SOCIETY OF
BIOLOGICAL CHEMISTS, INDIA

ANNUAL REVIEW
OF
BIOCHEMICAL & ALLIED RESEARCH IN INDIA
VOL. XXXIII FOR 1957

SEPTEMBER 1958
BANGALORE 3

CENTRAL FOOD TECHNOLOGICAL RESEARCH INSTITUTE
17.x.58
LIBRARY
MYSORE

PROFESSOR K. V. GIRI (1907—1958)

LIBRARY
MYSORE

OUR LATE PRESIDENT, PROFESSOR K. V. GIRI

The sudden demise of Dr. Giri on 17 July 1958 at Madras took away from our midst a well-loved personality and a distinguished biochemist of our country.

Kramadhati Venkata Giri was born near Madanapalle in 1907. Graduated from the St. Joseph's College, Trichinopally, he took the M.Sc. degree of the Calcutta University and then joined the Department of Biochemistry, Indian Institute of Science, Bangalore in 1929. His early work on "Investigations on Enzymes" gained him the degree of Doctor of Science of the Calcutta University in 1938. After two years of service as Enzyme Chemist at the Nutritional Research Laboratories, Coonoor (1939-40) and three years as Gowthami Lecturer and later Reader in Biochemistry at the Andhra University, he returned to the Institute at Bangalore in 1943, as lecturer in Biochemistry. He was elevated in 1950 to the professorial chair in Biochemistry, a post he held till the end. During 1949-50, he was associated with Prof. H. von Euler, at the University of Stockholm, Sweden and visited Norway, Denmark and England. He presided over a section of the International Symposium on Enzyme Chemistry held at Tokyo in the fall of 1957.

Dr. Giri was actively associated with executive and advisory committees of several universities, research institutions and technical bodies.

Dr. Giri's main interest in research was plant biochemistry particularly the mechanism of synthesis of oligosaccharides and starch in cereals and plants, a field to which he made several notable contributions. However, he was deeply interested in the spread of biochemical education. He held the firm conviction that to achieve this end, economical and highly simplified biochemical techniques are necessary prerequisites and he turned, in his characteristic way, his attention to the introduction of such of his modified techniques as circular paper chromatography and agar electrophoresis. He spared no pains to popularise them through his writings, lectures, radio-talks and visual demonstrations by charts and cine-films. His one great ambition in life was to see modern biochemical techniques reaching even the ordinary medical practitioner in this country, as he felt the future of scientific medical practice was greatly endangered by the threat of "divorce between biochemistry and physiology," and in recent years he set about to rectify this feature.

As a man, Dr. Giri was transparently honest, possessed abundance of tolerance and radiated genial sympathy for his fellowmen. His chief delight was in the laboratory where he preferred to work himself than to entrust work to others, if he could help it.

YOU CAN PRODUCE HONEY AT HOME

ENJOY A DELICIOUS AND NUTRITIVE
FOOD LIKE HONEY AND
ALSO MAKE MONEY IN YOUR SPARE TIME
LITTLE INVESTMENT NEEDED
BEE-KEEPING IS A FASCINATING, EDUCATIVE AND
PROFITABLE HOBBY

Read

THE INDIAN BEE JOURNAL

And keep up-to-date in Beekeeping knowledge
Current Volume Rs. 7.50 per year

A few copies of old issues are also available

Do you know? **Honeybees bring increased yields from various crops of fruits, vegetables and seeds and of several farm and fodder crops.**

Obtainable from :

The Bhupen Apiaries (Himalayas), Ramgarh,
DIST. NAINITAL, U.P., INDIA

AHURA CHEMICAL PRODUCTS PRIVATE LTD.

ACP LTD.

NON-IONIC SYNTHETIC DETERGENTS
AND EMULSIFYING AGENTS

Made for the first time in India
on a large Scale

AHURALAN L4 — Oil & Water Soluble wetting agent

AHURALAN S4 — Oil Soluble Emulsifying Agent

AHURALAN LD — Thickening Agent and Foam Stabiliser

ACINOL N — Compounded detergent similar to other commercial synthetic detergents

---

AVAILABLE IN LARGE QUANTITIES

Further information from :

Ahura Chemical Products Private Limited

84, SION ROAD, SION,
BOMBAY 22

Telegrams: AHURACHEM, Bombay Sion.

Phone H. O. : 61294
Factory : 67451

Society of
Biological Chemists, India

Annual Review of Biochemical and Allied Research in India
Vol. XXVIII for 1957

SEPTEMBER 1958
BANGALORE, 3

Price Rs. 6 or Sh. 12.

P. 3822

PRINTED AT
THE MODI POWER PRINTING WORKS,
12/13, LAL-BAGH FORT ROAD,
BANGALORE-2.

SOCIETY OF BIOLOGICAL CHEMISTS, INDIA

MEMBERS OF THE EXECUTIVE COMMITTEE FOR THE YEAR 1958

President

Prof. D. K. Banerji

Vice-Presidents

Prof. P. S. Sarma
Dr. K. K. Iya
Dr. R. Rajagopalan
Dr. B. Sanjiva Rao (Past President)
Dr. B. C. Guha (Past President)

Members of the Executive Committee

Dr. P. R. Mahadevan	Assam & West Bengal
Dr. D. P. Sadhu	,,
Dr. P. S. Krishnan	Bihar & Uttar Pradesh
Dr. S. N. Ray	,,
Prof. A. Srinivasan	Bombay
Dr. N. G. Magar	,,
Dr. S. M. Patel	,,
Dr. S. S. Rao	,,
Dr. G. P. Talwar	Delhi & Punjab
Dr. N. N. Dastur	,,
Dr. T. J. Boman	Poona
Dr. M. R. Raghavendra Rao	,,
Dr. K. T. Achaya	Hyderabad, Madhya Pradesh & Orissa.
Dr. M. C. Nath	

DR. M. PRASAD	Rajasthan & Madhya Bharat
MR. N. A. N. RAO	,,
DR. S. M. BOSE	Madras & Kerala
DR. K. S. G. DOSS	,,
DR. S. B. RAO	,,
DR. V. SUBRAHMANYAN	Mysore
DR. T. N. RAMACHANDRA RAO	,,
MR. N. SUBRAMANIAM	,,
DR. V. N. KRISHNAMURTHY	Bangalore
MR. H. SHIVA RAO	,,
DR. R. K. MALLER	,,
DR. C. S. VAIDYANATHAN	,,
DR. (MISS) S. ROYAN	,,
DR. R. S. SUBRAHMANYA	,,

Hon. Secretaries

DR. T. RAMAKRISHNAN
MR. P. R. SUNDARESAN
MRS. M. G. BHAT

Hon. Treasurer

DR. H. R. CAMA

Editorial Board

PROF. M. R. A. RAO
DR. B. H. IYER
DR. M. SIRSI
DR. S. C. PILLAI
PROF. P. S. SARMA
DR. G. TALWAR
PROF. M. C. NATH
DR. P. M. BHARGAVA
DR. (MISS) B. M. BRAGANCA

CONTENTS*

PAGE

1. ENZYMES
M. V. L. Rao ... 1

2. VITAMINS
S. D. Ambegaokar & S. M. Patel ... 12

3. GENERAL MICROBIOLOGY INCLUDING ANTIBIOTICS
F. Fernandes, J. M. D'Souza & A. Vaz ... 33

4. PHARMACOLOGY
M. L. Gujral & B. N. Dhawan ... 60

5. CHEMISTRY OF PLANT PRODUCTS
R. N. Chakravarti & B. Dasgupta ... 90

6. NUTRITION
S. M. Patel & M. V. Radhakrishna Rao ... 132

7. EXPERIMENTAL AND CLINICAL BIOCHEMISTRY
N. C. Dutta ... 153

8. DAIRY SCIENCE
James N. Warner ... 169

---

* The Society is grateful to the Council of the National Institute of Sciences of India for a generous grant for meeting a part of the cost of printing this Review.

THE EDITORIAL BOARD DOES NOT HOLD ITSELF
RESPONSIBLE FOR OPINIONS EXPRESSED
BY THE REVIEWERS

ENZYMES

M. V. L. RAO

Central Food Technological Research Institute, Mysore

During the year under review, the publications in the field of enzymology have remained the same as in previous years both in regard to the number and wide range of the systems investigated. It may, however, be pointed out that studies of a fundamental character bearing on the structural, functional and other aspects of enzymes have been few and far between.

1. OXIDATIVE ENZYMES

Kothare and DeSouza [1] published two preliminary notes relating to procedures for the cytochemical demonstration of succinic dehydrogenase in human leucocytes and spermatazoa based on the formation of blue formazan from p-nitrophenyl substituted ditetrazole (Nitro-BT).

Narurkar *et al.*[2] observed a considerable decrease in choline oxidase activity of the livers of host Wistar rats in which Yoshida sarcoma tumors had been induced by intraperitoneal transfer of ascites tumor cells. Addition of diphosphopyridine nucleotide (DPN) increased the activity to normal, indicating that DPN deficiency was mainly responsible for the lowered choline oxidase activity. From these and previous observations, the authors concluded that tumors grow by appropriating available nucleic acid precursors from the host organism thus depriving it of metabolites essential for its own synthetic activity.

In a study relating to the influence of dietary protein on liver-xanthine oxidase (XO) level, Esh and Som [3] assessed the efficiency of a number of pulse proteins with respect to the maintenance of the liver enzyme content. In weanling rats, the liver XO levels in animals fed Bengal gram or lentil proteins were distinctly lower than those fed casein at sub-optimal levels (6, 12 & 18%). Supplementation of pulse proteins with methionine enhanced the liver XO levels.

2. NON-OXIDATIVE ENZYMES

Phosphatases: Sampathkumaran *et al.*[4] demonstrated the presence of a phosphatase in soya bean and groundnut seeds which could dephosphorylate casein. The enzyme from these sources was purified and characterised on the basis of substrate specificity, pH optimum and behaviour toward metal ions. Their observations indicated that the enzyme is similar to the citrus fruit phosphatase (of Axelrod) but differs from the phosphoprotein phosphatase occurring in mammalian tissues.

Sundararajan and Sarma[5] studied the distribution of phosphoprotein phosphatase in rat tissues and described its purification. Rat spleen was found to be the richest source. Good yields of the purified enzyme with high specific activity were obtained from this source. The purified preparation was devoid of phosphomonoesterase and proteolytic activity. It could dephosphorylate all phosphoproteins indicating that it is a true phosphoprotein phosphatase. The pH-activity and the substrate concentration-activity curves of the enzyme indicated that the α and β forms of casein are dephosphorylated by one and the same enzyme.

Gupta *et al.*[6] made a comparative study of phosphomonoesterase and alkaline phosphatase activities in the guinea pig kidney. The former enzyme was estimated in homogenates and the latter by Glick's histochemical procedure in tissue sections. There was a close correspondence between the two activities.

Deb and Bannerjee[7] estimated histochemically the acid and alkaline phosphatases in the pituitary, adrenals, testes, ovary, kidney, liver and pancreas in scorbutic and pair-fed normal guinea pigs. In scurvy there was a decrease in alkaline phosphatase in the testes, ovary, kidney and some portions of the pituitary and an increase in the fascicular zone of the adrenals. The liver and pancreas showed no change. Acid phosphatase was increased in the kidney and decreased in the adrenal fascicular zone and slightly in the liver also. No alterations were found in the other tissues. The observed changes have been attributed to hormonal and metabolic factors.

Amylases and other Carbohydrases: Ghosh[8] studied the action of a number of dye stuffs on wheat β-amylase. Basic dyestuffs had absolutely no inhibitory effect while marked inhibition was observed in the case of the acid dyestuffs tested at a concentration of 1 : 2000 in the case of most dyes. Congo red showed a significant inhibition even at a dilution of 1 : 100,000. It has been suggested that the inhibition is due to the interaction of the acid groups of the dye with the reactive basic groups of the enzyme. Cyanin dyes had no inhibitory effect.

Murthy *et al.*[9] showed the presence of phosphorylase and Q-enzyme in tapioca roots, and described methods for the purification of the two enzymes. The optimum pH and temperature for the action of phosphorylase were 6.3 and 45°C. It was found to synthesise an amylose type of polysaccharide from glucose-l-phosphate. The optimum pH and temperature for the action of the Q-enzyme were 6.9 and 31°C. The reaction product obtained by the action of this enzyme on amylose had the properties of amylo-pectin. A similar polysaccharide was also formed by the combined action of the phosphorylase and Q-enzyme on glucose-l-phosphate. The presence of the Q-enzyme also exerted a pronounced accelerating effect on the rate of synthesis of polysaccharide by phosphorylase from glucose-l-phosphate.

Roy[10] prepared crystalline α-amylase from *Aspergillus oryzae* and examined the acid hydrolysate of the preparation for inositol activity using *Saccharomyces carlsbergensis* no. 4228 and demonstrated conclusively the absence of inositol in the enzyme.

Pant *et al.*[11] examined the actinomycetes from Indian soils with respect to production of active amylases from media composed of cheap indigenous ingredients, such as sesame and mustard oil cakes and rice bran extracts. Very encouraging yields were obtained and the activities of the amylase preparations compared favourably with the commercial brands of diastase.

Chandrasekhara and Swaminathan[12] investigated the amylases from Pearl millet (*Pennisetum typhoideum*). In the ungerminated condition, the grain contained little amylase activity. On germination, there was a marked increase in α-amylase activity with slight increase in β-amylase activity also. Both the α and β amylases showed optimal activity at pH 4.8 and 60°C. The critical inactivation temperature for the α-enzyme was 45°C at pH

4.8. The diastatic activity of the Pearl millet was less than that reported for barley, wheat and ragi.

Savur[13] demonstrated the presence in tamarind leaves of a polyose depolymerase—the enzyme which depolymerises the polysaccharide in tamarind seeds—and a polyose glucosidase which hydrolyses the polysaccharide further giving rise to reducing sugars and characterised the properties of both these enzymes. The occurrence of similar enzymes in certain moulds was also demonstrated.

Proteases: Bahadur and Chandra Sinha[14] studied the action of papain on casein. During the first hour of the reaction, the hydrolysis was proportional to the concentration of the enzyme at pH 4.4 and at all temperatures studied except at 70°C. During the subsequent two hours, the behaviour of the enzyme with increasing concentration was very different. This has been ascribed to the formation of a protein deactivator formed during the hydrolysis of the casein.

Rao and Rao[15] on the basis of kinetic studies showed the presence of two separate proteases in Russell's viper venom. The pH optima for the action of the two enzymes on heat denatured haemoglobin were 3.6 and 9.0. Heparin, which inhibits the blood clotting activity of the venom *in vitro*, completely inhibited the pH 3.6 protease but only partially the other protease. In mice heparin proved to be protective against the venom.

Esterases: Ganguly and co-workers[16,17] studied the general properties and specificity of rat liver Vitamin A esterase. The enzyme was active against only the acetate but not the stearate, palmitate or oleate, whereas the enzyme from the pancreas, small intestines, spleen and kidney hydrolysed all the four types of esters Blood plasma possessed slight activity. The erythrocytes were devoid of all esterase activity. The enzyme from the liver showed two pH optima at 6.6 and 8.6, the maximum activity being at the latter pH at a substrate concentration of 6×10^{-4} M. Qualitative comparisons of the activity of the enzyme preparation from the liver towards Vitamin A acetate and ethyl butyrate indicated that the Vitamin A esterase activity was more labile. Therefore, the authors drew the conclusion that there were two different activities in the preparation. In further studies, it was demonstrated that only small amounts of the Vitamin A ester are present in the blood stream while relatively large amounts are stored in the liver. On the basis of these findings, it has been suggested that the stored ester circulates in the blood and is hydrolysed in the different tissues during circulation.

Lipases: The progressive hydrolysis of groundnut oil by castor bean lipase was studied by Nizamuddin and Kulkarni[18] with particular reference to the characteristics of the free fatty acids liberated and of the unsplit residue. Appreciable changes in the saponification and iodine numbers of the fatty acids were observed. The changes in these constants of the unsplit residue were slight. The proportion of monoglycerides produced during the course of hydrolysis was uniformly low and did not exceed 3.5 per cent.

Gokhale and Godbole[19] studied the serum lipolytic activity and serum lipid partition in normal subjects as well as patients suffering from leprosy and tuberculosis. All the serum lipid constituents were diminished in these pathological conditions, but the lipolytic activity was lowered, suggesting a disturbance in fat metabolism.

Urease: Nath and Ullah[20] followed the kinetics of the highly active urease they had previously reported. The overall reaction was found to be of the first order within the substrate concentration range 0.01—0.1 M. The Michaelis constant (K_m) for the reaction was 0.0025 under the experimental conditions.

SPECIAL SYSTEMS

Folic Acid Cleaving Enzyme: Braganca *et al.*[21] described the preparation of an enzyme system from human blood which could degrade folic acid to yield p-amino-benzoyl-glutamic acid and 2-amino-4-hydroxy-6-formyl-pteridine. The enzyme system exhibited optimum activity at pH 5 and required adenosine triphosphate (ATP), Mn^{++} and glutathione (GSH) as essential co-factors. The enzyme system is apparently present in blood in an inactive state and is converted into the active form on treatment with hydrochloric acid. Heat-labile inhibitors appear to be present in the blood and could be separated from the active fraction by precipitation with ammonium sulphate. These inhibitors depress the splitting of folic acid when the co-factors are supplied by extracts prepared from blood but not when ATP, Mn^{++}, and GSH are present. Cysteine or thioglycolic acid cannot replace GSH as a co-factor. Coenzyme A (CoA) can partially serve this purpose. It has been suggested that folic acid cleavage in normal tissues may be important for the metabolic disposal of the vitamin, as also for the biosynthesis of biologically important conjugated pteridines, like 2-amino-4-hydroxy-6-formyl pteridine, which is known to be a potent inhibitor of xanthine oxidase.

Thiaminase: Deolalkar and Sohonie[22] examined a number of fresh water, brackish water and salt water fishes and found thiaminase in the tissues of all these species. The method of extraction of the enzyme was standardised and its kinetics studied. Evidence was obtained for the presence of only one thiaminase with a pH optimum at 7.0 in fresh water fish and probably of two thiaminases with pH optima at 3.6 and 5.6 in brackish and salt water fish. The latter two thiaminases were unstable at extremes of acidity and alkalinity and were completely inactivated in 24 hours at 28°C. Liver, spleen, kidney and viscera were rich in the enzyme. The presence of a heat stable, dialysable co-factor was demonstrated for all the three enzymes. Mn^{++} activated the thiaminases with pH optima at 3.6 and 5.6 but not the one with pH optimum at 7.0. None of the other metals tried could activate the latter thiaminase.

Flavokinase: Giri *et al.*[23] demonstrated the presence of an enzyme system in plants which synthesises flavin mononucleotide from riboflavin. The identity of the reaction products was established by chromatographic separation and fluorimetry. The occurrence of this enzyme in plant systems brings out the similarity in the biosynthetic pathways for such trace substances in living systems.

DHA Reductase: Hatvalne and Sohonie[24] studied the characteristics of dehydroascorbic acid reductase prepared from Neera (of the Date palm). The purified enzyme had maximum activity at pH 6.8 and 40°C, beyond which it was rapidly inactivated. Glutathione (GSH) was an essential hydrogen donor and could not be replaced by other thiol compounds. The activity of the enzyme was unaffected by cyanide and hydrogen sulphide, but was completely abolished by M/1000 sodium azide or iodoacetate. Lyophilized preparations of the enzyme retained their activity up to 16 days at 0°C.

Ascorbic Acid Synthesising System : Chatterjee *et al.*[25] isolated from rat liver homogenates, after centrifugal separation of nuclear and mitochondrial fractions, a system which could convert *in vitro* D-glucuronolactone into ascorbic acid in presence of 5×10^{-2} M potassium cyanide. In the absence of cyanide the conversion did not occur. Metabolic inhibitors like 2 : 4 dinitrophenol, sodium azide, chloretone and phlorizin were without any effect. Most of the original activity could be concentrated in a protein fraction precipitated at 30-50% saturation of ammonium sulphate. ATP at 0.0016 M concentration inhibited the synthesis in presence of cyanide to the extent of 40 to 50%. The system did not require co-factors like DPN, CoA or Mg^{++}; p-chloromercuribenzoate (PCMB) (10^{-3} M) and $HgCl_2$ (10^{-3} M) inhibited the synthesis considerably. The conversion did not occur in an atmosphere of nitrogen. Based on these observations, the authors conclude that the biosynthesis of ascorbic acid represents a competitive pathway to the normal metabolism of hexose which involves iron-dependent oxidising systems.

Histidase : Sivaramakrishnan and Sarma[26] found that p-chloromercuribenzoate (PCMB) and iodoacetic acid inhibited the activity of rat liver histidase. Glutathione reversed the PCMB inhibition indicating that the histidase may be a -SH containing enzyme. The authors have suggested that the site of action of the inhibitors in the degradation sequence of histidine is between histidine and urocanic acid.

INHIBITORS, ACTIVATORS, ETC.

The presence of a potent inhibitor in double bean (*Faba vulgaris*, Moench.), which retards the hydrolysis of the proteins of skim milk and wheat, was demonstrated by Apte and Sohonie.[27]

The inhibitor seems to affect the release of some amino acids selectively and the inhibition decreases with the progress of digestion. Fed at a level of 0.265% in the diet, it did not inhibit the growth of rats.

Siddappa[28] reported the presence of a powerful trypsin inhibitor in raw Jack fruit seed. The inhibitor is extractable with phosphate buffer (pH 7.7) or HCl (0.05N). Autoclaving at 10 psi for 30 minutes, or boiling the seeds in water or saline, completely destroyed the inhibitor.

Deolalkar and Sohonie[29] found that a number of aromatic amines including niacin and niacinamide and also sodium cyanide activated the thiaminase from the salt water fish, Mendeli (*Coilia dussunieri*). Evidence was adduced to prove that the amino group is primarily responsible for the activation. Amino acid amino groups did not activate the enzyme.

Mohan Rangam and Manjrekar[30] studied the effect of penicillin and chloramphenicol on staphylophosphatase and staphylocoagulase of 73 strains of staphylococci. Antibiotics inhibited both the enzymes, chloramphenicol inhibiting phosphatase production in all the strains and penicillin in only 67 strains. The findings point to the unreliability of the tests for pathogenecity based on these two enzyme activities if antibiotics have been administered to the human host.

MISCELLANEOUS

Rindani and Valanjee[31] found a significant increase in oxygen uptake and succinic dehydrogenase activity in the livers of castrated male albino rats (28-30 days old) 50 days after the operation.

Bharadwaj[32] reported that in maleic acid toxicity induced in young albino rats, there was no quantitative reduction of either alkaline phosphatase or succinic dehydrogenase level in the kidney as judged by histochemical staining procedures.

Nagabhushanam *et al.*[33] studied the oxidative enzymes and phosphatases in *Agave vera cruz* Mill. By ammonium sulphate fractionation a thirty-fold increase in peroxidase activity was obtained, whereas there was only a two-fold increase in the phosphomonoesterase activity. The esterase exhibited two pH optima at 3.5 and 5.5. Mg^{++} had no activating effect on either of these acid phosphatases.

Shrivastava and co-workers[34, 35, 36] made a detailed study of the oxidative and transaminase systems of virulent and avirulent strains of *Pasteurella pestis.* Chlorotetracyclin, oxytetracyclin and tetracyclin markedly inhibited oxidative metabolism when glucose and serine were the substrates. Neomycin, streptomycin and chloromycetin slightly inhibited serine metabolism but activated glucose oxidation. Sulpha drugs had no effect.

A large number of dehydrogenases were found to be present in the resting cells of the organism. The optimum pH for the lactic dehydrogenase was 7.0. Chlorotetracyclin completely inhibited succinic dehydrogenase activity, whereas other antibiotics inhibited the enzyme only partially. The microbial transaminase had a pH optimum at 8.0 and did not require extraneous pyridoxal phosphate excepting for the alanine-α-ketoglutarate system. Mercuric sulphate inhibited the microbial transaminase systems while sulpha drugs and antibiotics had no action on the systems.

Pathak and Shrivastava[37] studied the blood pseudo-cholinesterase activity in normal individuals and in people with liver disorders and came to the conclusion that the esterase activity, as well as alkaline phosphatase activity of the serum are two of the important tests which could be used for the differential diagnosis of hepatocellular and obstructive jaundice.

Patwardhan and Sastry[38] studied the effect of asafoetida on several intestinal (wall) enzyme systems—dehydrogenases, esterase, peptidase, phosphatase and invertase—*in vitro*. No significant effects were observed on any of the activities tested. With regard to endogenous dehydrogenase activity, there was a slight increase in presence of boiled muscle extract, but a slight decrease in presence of triphenyltetrazolium chloride. Since the changes were of a small order, the types of dehydrogenases affected were not further investigated.

REFERENCES

1 DeSouza, E. J. and Kothare, S. N. (1957), Curr. Sci., **26**, 355.

2 Narurkar, M. V., Kumta, V. S. and Sahasrabudhe, M. B. (1957), Nature, Lond., **180,** 1128.

3 Esh, G. C. and Som, J. M. (1957), Ann. Biochem. & Exptl. Med., **17.** 117.

4 Sampathkumaran, K. S. V., Sundararajan, T. A. and Sarma, P. S. (1957), Enzymologia, **18**, 228.

5 Sundararajan, T. A. and Sarma, P. S. (1957), *Ibid.*, **18**, 234.

6 Gupta, P. S., Ghosh, S. N. and Chatterjee, J. (1957), Ann. Biochem. & Exptl. Med. **17**, 97.

7 Deb. C. and Bannerjee, S. (1957), Proc. Nat, Inst. Sci., India, **23**, 1.

8 Ghosh, A. K. (1957), Enzymologia, **18**, 76.

9 Murthy, H. B. N., Rama Rao, G. and Swaminathan, M. (1957), *Ibid.*, **18,** 63.

10 Roy, D. K. (1957), Ann. Biochem. & Exptl. Med. **17,** 127.

11 Pant, K. D., Shete, K. and Krishnamurti, C. R. (1957). J. Sci. Industr. Res. (India), **16C**, 101.

12 Chandrasekhara, M. R. and Swaminathan, M. (1957), *Ibid.*, **16C**, 35.

13 Savur, G. R. (1957), J. Indian Chem. Soc. (Ind. and News Edn.), **20,** 55, *Ibid*., **20,** 62.

14 Bahadur, K. and Chandra Sinha, R. (1957), Enzymologia, **18,** 288.

15 Shantha Rao, S. and Srinivasa Rao, S. (1957), J. Sci. Industr. Res. (India), **16C**, 148.

16 Sastry, P. S., Krishnamurthy, S. and Ganguly, J. (1957). Indian J. Med. Res., **45**, 263.

17 Krishnamurthy, S., Sastry, P. S. and Ganguly, J. (1957), *Ibid.*, **45**, 391.

18 Nizamuddin, H. and Kulkarni, B. S. (1957), J. Sci. Industr. Res. (India), **16C**, 217.

19 Gokhale, S. V. and Godbole, S. H. (1957), Indian J. Med. Res., **45**, 327.

20 Nath, R. L. and Ullah. R. (1957) Ann. Biochem. & Exptl. Med., **17,** 39.

21 Braganca, B, M., Aravindakshan. I. and Ghanekar, D. S. (1957), Biochim. et Biophys. Acta, **25**, 623.

22 Deolalkar, S. T. and Sohonie, K. (1957), Indian J. Med, Res. **45,** 571.

23 Giri, K. V., Krishnaswamy, P. R. and Appaji Rao, N. (1957), Nature, Lond., **179,** 1134.

24 Hatvalne. B. V. and Sohonie, K. (1957), Ann. Biochem. & Exptl. Med., **17**, 53.

25 Chatterjee, I. B., Ghosh, N. C., Ghosh, J. J., Roy, R. N. and Guha, B. C. (1957), Sci. & Cult., **23,** 50.

26 Sivaramakrishnan, V. M. and Sarma, P. S. (1957), J. Sci. Industr. Res. (India), **16C**, 14.

27 Apte, U. and Sohonie, K. (1957), *Ibid*,, **16C**, 225.

28 Siddappa, G. (1957), *Ibid.*, **16C**, 199.

29 Deolalkar, S. T. and Sohonie, K. (1957), Indian J. Med. Res., **45**, 587.

30 Mohan Rangam, C. and Manjrekar, P. S. (1957), Indian J. Med. Sci., **11**, 896.

31 Rindani, T. H. and Valanjee, N. N. (1957), Curr. Sci., **26**, 88.

32 Bharadwaj, T.P. (1957), *Ibid.*, **26**, 179.

33 Nagabhushanam, A., Srinivasan, K. S. and Srinivasan, M. (1957), J. Sci. Industr. Res. (India), **16C**, 127.

34 Srikantan, T. N., Agarwala, S. C. and Shrivastava, D. L. (1957) Indian J. Med. Res., **45**, 151.

35 Saxena. K. C., Sagar, P. Agarwala, S. C. and Shrivastava, D. L. (1957), *Ibid*,, **45**, 161.

36 Srikantan, T. N., Agarwala, S. C. and Shrivastava, D.L. (1957), *Ibid.*, **45**, 467.

37 Pathak, M. A. and Shrivastava, J. B. (1957), Indian J. Med. Sci., **11**, 588.

38 Patwardhan, M. V. and Sastry, L. V. L. (1957), Food Sci. (Bull., C.F.T.R.I., Mysore), **6**, 27.

VITAMINS

S. D. AMBEGAOKAR & S. M. PATEL
Department of Nutrition
Haffkine Institute, Bombay

Progress in vitamin research has steadily been maintained as judged by the number of publications; during the year under review, they are almost the same as in the previous years. Folic acid and vitamin B_{12} continues to draw comparatively more attention.

Carotene and Vitamin A

Balasundaram *et al.*[1] have reported that the spectrophotometric values of $E^{1\%}_{1cm}$ (gross) × 1600 and $E^{1\%}_{1cm}$ (corrected) × 1910 (cyclohexane) at 328 mμ for vitamim A do not agree in the samples of fish oils which undergo oxidation and deterioration during storage. In such samples, the value of $E^{1\%}_{1cm}$ (gross) at 328 mμ × 1600 gave them a high figure for the vitamin A. The authors have, therefore, stressed the necessity of either applying a correction equation or separating the constituents chromatographically before estimating vitamin A potency in oxidised fish oils. On the other hand, they observed the $E^{1\%}_{1cm}$ value at 290 mμ almost unaltered. They have, therefore, indicated the significance of this value in assessing the original vitamin A potency of the stored oil. The two extraction procedures (steam and solvent) adopted by them for the extraction of oil from livers did not show any variation in the vitamin A potency, indicating that steam extraction has no deleterious effect on the vitamin. They confirmed the absence of vitamin A alcohol, previously observed by them in fresh marine fish liver oils by chromatographic analysis.

Roy [2] studied the stability of vitamin A acetate in vanaspati enriched with 'vanitin' (Hoffman-La-Roche) under different conditions of storage and heating. About 50% of vitamin A was destroyed in 5 months as a result of storage in loose cover cans.

The decrease in vitamin A content was greatest during the first fortnight, after which the rate of destruction was low. The protection afforded by the various antioxidants, such as ethyl and propyl gallate, nordihydroguaiaretic acid (NDGA), butylated hydroxyanisole (BHA) and Tanox II (Eastman Kodak) was insignificant. However, ethyl and propyl gallates and NDGA were found effective in controlling the increasing tendency of peroxide value. They have also studied the effect of different cooking temperatures on the stability of vitamin A, particularly when the same vanaspati was used in frying successive batches of food.

Sastry *et al.*[3] investigated the distribution and general properties of vitamin A-esterase activity in various tissues of rat, using vitamin A-acetate,-strearate,-palmitate,-oleate and ethyl butyrate as substrates. Liver was found active towards the acetate only while pancreas, small intestine, spleen, and kidneys were active against all the four esters. Blood plasma showed slight activity against the acetate. Red blood cells were completely devoid of vitamin A-esterase activity. They noted for the liver vitamin A-esterase two pH optima at 6.6 and 8.6, the maximum activity being at pH 8.6 with a substrate concentration of 6×10^{-4} M. It was also shown by qualitative comparison that activities of the enzyme system in rat liver towards vitamin A-ester and ethyl butyrate are not identical. Activity towards vitamin A-acetate was found to be more labile under different conditions of treatment, such as inhibiting effect of various metallic ions, a few alkaloids, acetone drying, ageing and heating. They (Krishnamurthy *et al.*[4]) have further indicated that blood and liver enzymes were ineffective in bringing about the hydrolysis of the natural vitamin A-ester present in liver or in blood; whereas tissues, such as pancreas, small intestine, spleen and kidneys were able to do so. The presence of small amounts of vitamin A-ester in the normal circulating blood was confirmed. Based on these observations, they have suggested that vitamin A-ester of normal circulating blood comes from the liver and is hydrolysed by tissues other than blood and liver during the course of its circulation along with blood.

De and Dikshit [5] studied the influence of dietary phosphorus on the metabolism of carotene and its storage in liver as vitamin A. For this purpose, two groups of rats were fed diets *ad libitum* containing low and normal amount of phosphorus. A known daily dose of β-carotene (65 μg) was fed *per os* to all animals. They reported almost identical absorption of carotene from intestine in both the groups as judged by the faecal excretion of carotene. The differences between the total liver-vitamin A values obtained in rats of the two groups at various intervals, were also not significant.

Cama *et al.*[6] observed that iodinated casein decreased, whereas thiourea increased the liver reserves of vitamin A, when retinene was administered orally to rats; thiouracil did not show any significant effect. On the other hand, on administration of carotene, hyperthyroid rats stored larger amounts of vitamin A in the livers and hypothyroid rats accumulated much less vitamin A. Thyroid activity did not seem to have any direct effect on the conversion of intravenously administered retinene to vitamin A, as observed by identical vitamin A values in the liver. They have also recorded the effect of thyroid activity and vitamin A deficiency on changes occurring in serum protein components.

Bharucha and Shankarnarayan [7] reported on the carotene content of a few grasses obtained from the suburbs of Bombay city. They found that the Bombay grasses contained a deplorably smaller amount of carotene than certain American grasses like switch grass and side oat grass. *Arundinella lawii*, as compared to the other grasses analysed, seemed to have the highest carotene content (5.00 mg %). It was also noticed that the carotene content varied directly with the amount of moisture content of grasses.

Thiamine

Sastri and Indravati [8] analysed 126 samples of human milk at various stages of lactation as a part of the investigation into the prevalence of beriberi in the Northern circars area of the Andhra State. They observed low thiamine content in the early days of lactation, the amount of thiamine rising gradually till the end of the first month; thereafter, it varied within a narrow range throughout the six months of lactation. Thiamine content in 93 samples of mature milk ranged from 3.12 to 25.47 μg, with an average of 12.24 ± 0.49 μg per 100 c.c. Although mother's age or parity did not seem to influence the thiamine content of the milk, the average vitamin content of the samples from different localities differed significantly. They observed that changes in the dietary intake of thiamine influenced the vitamin content of milk. On ingestion of crystalline thiamine hydrochloride (10 mg daily for one week), the vitamin concentration in the milk increased significantly; the rise was greater when the original level of thiamine was low. Taking into account the daily yield of milk and thiamine concentration, they found that the average daily intake of thiamine by an infant of this particular area was less than 75 μg, which is far below the required amount (200 μg) reported in the literature.

Balakrishnan *et al.*[9] studied the effect of continued feeding of curds on intestinal micro-flora and biosynthesis of thiamine in sulfaguanidine-fed rats. Data in this respect were obtained by feeding three types of diets—(1) basal thiamine-free diet, along with sulfaguanidine in alternate weeks, (2) basal diet along with curds or sulfaguanidine in every alternate week, (3) basal diet plus synthetic thiamine along with sulfaguanidine in alternate weeks. In the first experiment in which the curds were fed continuously, the rate of growth of rats was more or less uniform during six weeks of the experiment, in spite of receiving sulfaguanidine in alternate weeks. Similarly, thiamine excretion in urine and faeces was fairly constant indicating a uniform rate of synthesis during the entire period of six weeks. No significant reduction in the number of coliform bacteria in faeces was produced. In the second experiment in which curds or sulfaguanidine were fed in every alternate week, an alternate rise and fall in thiamine synthesis was observed in the initial stages; but later on there was no appreciable reduction in synthesis of thiamine or in the number of coliform bacteria, suggesting thereby the persistent antagonistic effect of curds towards the action of sulfa drugs after lapse of certain periods. Sulfaguanidine brought about complete inhibition in the synthesis of thiamine followed by a considerable fall in the body-weight of animals. Some animals of this group died before the close of the experiment. They showed that the animals receiving curds had greater stores of thiamine in liver than those receiving synthetic thiamine. Baliga *et al.*[10] repeated the same experiments using modified diets containing 18% casein and additional vitamins, such as biotin, folic acid, vitamins B_{12} K and E. Their previous observations that ingestion of curds increased the synthesis of thiamine in thiamine restricted diet and that it overcame the inhibitory effect of sulfaguanidine on thiamine synthesis were confirmed. In a somewhat different experiment, Bhagavan and Rajagopalan [11] observed that the supplementation of banana at 10% level on the basis of dry weight to a poor rice diet favoured the rate of growth and the intestinal synthesis of thiamine. The animals on supplementary diet also showed increased level of thiamine in the liver.

Deolalkar and Sohonie [12-13] investigated the properties of thiaminase occurring in varieties of brackish, salt and fresh water fish. Thiaminase being water soluble they could easily extract it by merely keeping the minced mass in contact with water. Optimum activity of thiaminase was found to be at 37°C. However, the pH optima were different. Thiaminase from fresh water fish showed its maximum activity at pH 7.0, while that from varieties of brackish and salt water fish showed optimum activity at pH 3.6, 5.6 and 7.0. These observations indicated the probable presence of three thiaminases in salt water fish. Fairly equitable distribution of the thiaminases in different organs of fish was noticed. An organ which was rich in one thiaminase was equally rich in the other thiaminases as well. All the three thiaminases lost part of their activity almost to the same extent on dialysis, due to loss of co-enzyme in dialysate. The authors were able to restore the activity by the addition of boiled original extract. Experiments on interchangeability of co-enzymes showed that the co-enzyme from one fish can activate the apo-enzyme of any other fish. Manganese and cobalt activated dialysed extracts of thiaminase 3.6 and thiaminase 5.6. None of the metals tested could restore the activity of thiaminase 7.0 from all the three sources. The authors have also reported on the activating effect or otherwise of certain aromatic amines and related compounds.

Riboflavin

In an attempt to find out a cheap raw material suitable for industrial production of riboflavin by *E. ashbyii*, Lulla and Johar[14] reported rice and wheat brans to be suitable culture media which gave fairly good yields of riboflavin. Maximum yield of riboflavin was obtained when a mixture of one part of the wheat bran and 1.5 parts of phosphate buffer (pH 7.0) was employed as the medium. A riboflavin concentrate containing 8-10 mg of the vitamin per g. of the product was prepared from wheat bran medium.

Nicotinic acid

Banerjee and Basak[15] followed the biosynthesis of nicotinic acid from tryptophane with special reference to site of formation and also studied the role of pyridoxine and ascorbic acid in the conversion of tryptophane to nicotinic acid. They observed a decrease in the urinary excretion of quinolinic acid and N-methyl nicotinamide by monkeys receiving extra tryptophane and sulfaguanidine or chloromycetin. This indicated that intestinal micro organisms were concerned with the conversion of tryptophane to nicotinic acid. However, the rate of excretion was still high compared with that observed in controls receiving no such compounds (tryptophane, sulfaguanidine, chloromycetin). These observations led them to believe that, besides the intestinal tract, other tissues might also be concerned in the biosynthesis of nicotinic acid from tryptophane. The liver of monkeys was not concerned in the synthesis of the vitamin, as could be seen from the normal excretion of nicotinic acid metabolites even after intraperitoneal injection or carbon tetrachloride. On the other hand, pyridoxine supplement led to an increased excretion of nicotinic acid and its metabolites by tryptophane and sulfaguanidine fed monkeys. They have, therefore, suggested that pyridoxine is needed for the conversion of tryptophane to nicotinic acid. Ascorbic acid deficiency had no effect on the excretion of these metabolites.

Desai and Chitre[16] confirmed their earlier work that there was a decrease in the alkali-labile precursor of niacin and a simultaneous and almost equivalent increase in the niacin content, when the germinating fluid contained 1 – or dl-tryptophane. On replacing the germinating fluid by distilled water after certain period, the conversion of the precursor to nicotinic acid was almost stopped. This suggested that the presence of the amino acid is a condition precedent for the reduction of alkali-labile precursor. They further observed that the concentration of amino acid in the germinating fluid influenced the extent of the release of niacin from the alkali-labile precursor. In order to study the nature and role of this alkali-labile bound form of nicotinic acid, Chitre and Raut [17] followed the sequence of changes in the niacin metabolites during the growth of paddy. It was observed that nicotinic acid was first synthesised and the alkali-labile bound nicotinic acid and other products of nicotinic acid metabolism followed. With the data available, the authors presumed that alkali-labile bound form might possibly be an accumulated product of niacin metabolism.

Das and Guha [18] isolated from wheat bran a bound form of nicotinic acid similar to 'niacinogen' obtained earlier by them (Guha and Das [19]) from rice. The substance separated as shining russet-coloured rectangular plates. The yield was 40-60 mg. per 100 g. wheat bran. Analysis gave the following figures: C, 46.26; H, 7.35; N, 12.95 per cent. It gave a blue fluorescence in ultraviolet light, which changed to yellowish green on treatment with alkali. From the same laboratory, Das and Ghosh [20] reported a modified method for the estimation of alkali-labile bound nicotinic acid (BNA) in rice and wheat bran. They extracted free and bound nicotinic acid by treating the material with N/10 HCl and heating in a water-bath at 90°C for 40 minutes with frequent stirring. The extract was divided into two parts to estimate nicotinic acid before and after hydrolysis. The coloured compound formed by the action of cyanogen bromide on free nicotinic acid in the presence of p-aminobenzoic acid was extracted with amyl alcohol and was measured in a Lumetron photo-electric colorimeter, using B420 filter. The difference in nicotinic acid values obtained before and after alkali hydrolysis of the extract represents the correct value of BNA in cereal brans in terms of nicotinic acid. The colour developed due to BNA before hydrolysis is not extractable with amyl alcohol. The results of recovery experiments showed that the method is reasonably reliable. The authors observed that the nicotinic acid present in rice and wheat brans was almost in bound form.

Pyridoxine

Nadkarni and Sreenivasan [21] studied the effect of vitamin B_6 deficiency on serine decarboxylation in rats. Experiments have been carried out to establish the optimal conditions, such as the substrate concentration and the pH on the activity of serine decarboxylase. Activation effect of pyridoxine phosphate and inhibitory effect of hydroxylamine on these enzyme systems were also studied. The authors have shown that serine decarboxylase was not influenced by pyridoxine deficiency in rats. Although a function for vitamin B_6 in serine decarboxylation seemed doubtful, the experiments clearly brought out a relationship of this vitamin to glycine-serine conversion and in serine deamination as in microorganisms. The values for total choline were reduced in the deficient rats but the levels of free choline seemed to be almost unaltered.

Pantothenic acid

Thangamani and Sarma [22] studied the role of pantothenic acid in the conversion of the precursors, glucose-cyclo-aceto-acetate and d-glucuronolactone, to ascorbic acid in rats. They observed lower excretion of ascorbic acid in pantothenic acid deficiency. In the control rats the excretion of ascorbic acid increased after an injection of glucose-cyclo-aceto-acetate, whereas there was no such increase in the case of deficient rats. It was also observed that out of the injected amount of glucose-cyclo-aceto-acetate, a greater part was excreted unmetabolised by the deficient rats than by the control rats. Based on these observations, the authors have indicated that pantothenic acid is required for conversion of the precursor to ascorbic acid. Similar experiments with d-glucuronolactone showed that pantothenic acid was not needed for its conversion to ascorbic acid.

Folic acid and Vitamin B_{12}

Shenoy *et al.*[23] described some modifications in the *Euglena gracilis* assay procedure for serum vitamin B_{12}. This modified method was found suitable for local conditions, was more sensitive and released the bound vitamin B_{12} in human blood serum. The results showed the presence of a heat-labile, charçoal adsorbable growth inhibitor in the supernatant of a *Euglena* culture of 8 to 10 days old. Its similar inhibitory action on *L. leichmannii* was also shown. The inhibition was abolished and the sensitivity of the method was increased by using a ten-fold dilution of the culture or by using washed cell suspension. They obtained maximum values for total vitamin B_{12} content of human blood serum when the samples were digested with papain at 60°C for one hour and thereafter steamed for 5 minutes in presence of metabisulphite (1 mg./ml.) as stabilizer. Ghosh and Datta [24] used *Escherichia coli* mutant 301 for the assay of vitamin B_{12} in various pharmaceutical preparations containing, besides other vitamins, methionine and its derivatives. The presence of other growth factors, such as methionine and/or its derivatives which made the assay of vitamin B_{12} difficult, were eliminated from the materials to be assayed by adsorption on Deacidite F.F. (a highly basic resin based upon cross linked polystyrene containing quaternary ammonium groups). This method of separating vitamin B_{12} from methionine and methionine-like bodies was quite satisfactory, since the values were similar to those obtained by spectrophotometric analysis.

Joshi and Sohonie [25] carried out investigations to characterize the factor or factors in palm gur possessing vitamin B_{12} like activity employing *Escherichia coli*, *Lactobacillus leichmannii* and *Euglena gracilis* as test organisms. They observed the presence of vitamin B_{12}—like substances in all the varieties of gur investigated. The alkali-stable B_{12}—like activity obtained in gurs was presumed to be due to vitamin B_{12}—like substances which might have been protected from destruction by certain stabilizer systems under the conditions employed.

Shreenivasamurthy *et al.*[26] studied the different factors affecting the stability of vitamin B_{12} in proteolysed liver extract. The liver digest stored in bottles exposed to diffused light lost nearly

87% of its potency within 6 months. Addition of metabisulphite and sodium nitrite helped in preserving 40% of the total potency in the same period of storage. Sodium cyanide, however, seemed to offer the maximum protection. The vitamin remained stable when stored in completely filled sealed bottles or in bottles sealed after evacuation or after filling with an inert gas. Thus, they demonstrated that light and air are the primary agents affecting stability of vitamin B_{12}.

Using rice moth larva (*Corcyra cephalonica ST*), Shivaramakrishnan and Sarma[27] concluded that vitamin B_{12} did not possess growth promoting property. However, they demonstrated the counteracting action of the vitamin against the growth inhibition induced by the presence of raw soya bean meal extract in the diet of the insects.

Altekar *et al.*[28] observed the influence of vitamin B_{12} administered orally or by an intra-muscular injection on the excretion of N_1-methyl-nicotinamide. Vitamin B_{12} when given orally did not cause any rise in the output of N_1-methyl nicotinamide. But when it was administered by an intramuscular injection, although the small doses did not cause any rise in the output of N_1-methyl nicotinamide, a dose of 500 μg increased its excretion.

Nadkarni *et al.*[29] studied the effect of nicotinamide administered intraperitoneally in vitamin B_{12} deficient mice on liver pyridine nucleotides. They observed that the incorporation of nicotinamide into liver pyridine nucleotides, which reached a maximum level in 8 hours in control rats, was less in vitamin B_{12} deficiency. They also observed that vitamin B_{12} offered protection against carbontetrachloride toxicity as could be seen from the ratio of PN/PNH (pyridine nucleotide/reduced pyridine nucleotide) which was more in protected rats.

Ganguly & Bhattacharya[30] described a method for the estimation of folic acid in presence of iron salts. They studied the extent of interference caused by the addition of varying amounts of iron salts, viz. ferrous gluconate, ferric ammonium citrate and ferrous sulphate in the colorimetric determination of folic acid. They have indicated that the folic acid in liver extracts and B-vitamin solutions containing iron salts could be satisfactorily determined after removal of the iron as sulphide.

It was shown by Nadkarni and Sreenivasan (*loc-cit.*) that pyridoxine deficiency had no influence on serine decarboxylation. In continuation of the work, the same authors (Nadkarni and Sreenivasan[31]) investigated the effect of folic acid deficiency in serine decarboxylation. They observed a reduction in serine decarboxylase activity of rat liver in folic acid deficiency ; also a reduction in leucocyte count, liver folic acid, liver and blood choline—both free and combined was noted. Folic acid was not found to influence serine deamination, but glycine to serine synthesis was impaired in a dietary deficiency of the vitamin. They showed that the addition of aminopterin inhibited, while addition of folic acid accelerated serine decarboxylation, *in vitro*.

While studying the relationship between vitamin B_{12} and folic acid, Narayanan *et al.*[32, 33] observed an apparent elevation of serum vitamin B_{12} levels produced by two daily injections of 25 mg. of folic acid in 26 patients with nutritional macrocytic anaemia (NMA), especially in those cases where the vitamin B_{12} stores were augmented by prior parenteral therapy. However, the changes in free vitamin B_{12} levels were small and of doubtful significance. A reciprocal relationship was also indicated by a similar rise in serum folic acid levels following the parenteral administration of two 100 μg doses of vitamin B_{12} on consecutive days. The authors assumed that the effect of intramuscular injection of folic acid on serum vitamin B_{12} level was due to mobilization of vitamin B_{12} from body stores. This assumption was based on the fact that the increase was more striking in those patients where vitamin B_{12} stores were replenished by medication with B_{12}.

Mulgaonkar and Sreenivasan[34] followed the alterations in the electrophoretic pattern of serum proteins and blood and liver picture in folic acid and vitamin B_{12} deficiency in rats. Deficiency in these two vitamins caused reduction in leucocytes, haemoglobin, red blood cells, liver folic acid and vitamin B_{12} and serum vitamin B_{12}. Also a significant reduction in total serum proteins and in serum albumin, α_1-globulin and γ-globulin was observed, although the percentage of total protein as γ-globulin was the same. At the same time they observed an increase in the proportion of β-globulin. They further demonstrated that dietary protein level influences serum concentrations of albumin, α_1-globulin and, to a lesser extent, γ-globulin.

Alimchandani and Sreenivasan [35] studied the nature of the oxidation product of vitamin B_{12} which inhibits growth of *E. coli* (Macleod) with special reference to reversal of inhibition by vitamin B_{12}, folic acid, PABA, yeast extract, peptone, *E. coli* crushed cell extract and a mixture of amino acids. They found that none of the foregoing vitamins tried singly or in combination could reverse the growth-inhibition ; while the other substances were effective in overcoming growth-inhibition of the B_{12} oxidation product to an appreciable extent. Their observation that the amino acid mixture partially reversed growth-inhibition and not an individual amino acid led them to suggest that the oxidation product functioned by inhibiting the synthesis of more than one amino acid.

The same authors (Alimchandani and Sreenivasan [36]) studied the effect of folic acid and vitamin B_{12} on the growth and on the nucleic acid synthesis in the presence of penicillin in *Lactobacillus casei* (A.T. C.C. 7469). Since these studies related to an organism requiring PGA for growth, the effects of B_{12} were ascertained only in the presence of PGA. The concentration of penicillin to bring about approximately 50 per cent growth-inhibition in presence of optimal concentration of PGA (0.3 mcg./ml.) was found to be 0.2 units/ml. Using this concentration of the antibiotic, the influence on growth-inhibition of varying concentrations of PGA, with and without B_{12}, was studied. They observed that folic acid alone and more effectively, with B_{12}, partially overcame the antagonistic effect of penicillin on synthesis of PNA in a manner similar to its protective effect against growth-inhibition by the antibiotic. DNA remained unaffected.

Alimchandani and Srinivasan [37] also investigated the reversal process of sulfadiazine (SD) growth-inhibition in *Escherichia coli* in the presence of several metabolites, besides methionine—xanthine, serine, thymine and valine, which are functionally related to p-amino benzoic acid which was found to be effective in reversing growth-inhibition. They thought that such a study was necessary in view of their observation that with sulfadiazine (SD) as inhibitor at high concentration (50 mg %), the metabolites (methionine, xanthine, serine, thymine and valine) were no longer sufficient to reverse growth inhibition. In studies with amino acids added in combination and singly in the presence of the above mentioned metabolites, they observed that only glycine and, to a lesser extent threonine were active in partially reversing SD growth-inhibition. The effect of threonine was due to its conversion to glycine in the organism. From studies with varying concentrations of glycine and serine added singly and in combination, they concluded that SD blocked the biosynthetic mechanism(s) for glycine-serine interconversion. Amongst the vitamins, only vitamin B_{12} was observed to have an ability to reverse SD inhibition. Glycine and vitamin B_{12} in combination showed reversal effects which nearly approached that obtained with PABA. Another observation they have recorded is that the substitution of xanthine by a mixture of purines in the presence of other metabolites, including glycine and B_{12}, gave reversal of growth-inhibition comparable to that obtained with PABA. On the other hand, folic acid or leucovorin (LV) were inactive in reversing SD growth-inhibition or in replacing any of the SD reversing metabolites even in the presence of excess of B_{12}. Homocysteine or homocystine could not replace methionine even in combination with B_{12}. The work was further extended by Alimchandani and Sreenivasan [38] to explain the observed inactivity of PGA derivatives in replacing PABA in overcoming inhibition of *E. coli* by SD. The question was examined from three points: (1) synthesis of folic acid active factor(s) by *E. coli*, (2) characterization of folic acid active factor(s) elaborated by *E. coli*, and (3) utilization of PGA and LV by the cells of *E. coli*. The culture filtrate of *E. coli* was found to possess folic acid and citrovorum factor activities. However, the growth response curve of *S. faecalis* strain R in the presence of the filtrate of *E. coli* was different from those obtained in the presence of PGA and LV. Using methyl folic acid and amino-pterin as growth inhibitors of *S. faecalis*, they found that the inhibition index of the culture filtrate was different from those of PGA and LV. On bioautography of the culture filtrate they noticed the existence of at least two factors distinct from the both PGA and LV. Evidence indicating the impermeability of cells of *E. coli* to PGA and LV was presented.

In continuation of the work mentioned above, experiments are reported (Alimchandani and Sreenivasan[39]) explaining the relationship between the growth-inhibition and the accumulation of 4 amino-5-imidazole carboxamide by *E. coli* during SD bacteriostasis with special reference to the effects of PGA, LV and vitamin B_{12}. As before, it was observed that LV or PGA did not reverse growth-inhibition by SD ; nor they had any effect on amine accumulation. On the other hand, both vitamin B_{12} and methionine influenced growth-inhibition as well as amine formation at varying concentrations of SD. Reversal of growth was more pronounced and the amine accumulation per unit growth was less with vitamin B_{12} than with methionine. The trend of the results indicated that although SD blocked the conversion of the amine to purine in proportion to its concentration, there seemed no direct relationship between accumulation of amine and growth in the presence of vitamin B_{12} or methionine. These observations were interpreted to mean that the involvement of B_{12} and methionine in amine to purine conversion was only indirect, their primary effect being on growth. This view was further borne out by the fact that vitamin B_{12} or methionine dificiency did not cause accumulation of amine in *E. coli* mutant and that ethionine and a vitamin B_{12} oxidation product depressed growth of *E. coli* but no amine accumulation was observed.

Kasbekar and Sreenivasan[40] have excellently reviewed the present state of our knowledge of the role of vitamin B_{12} in sulphydryl and oxidative metabolism in experimental animals.

Biotin

Nadkarni and Sreenivasan[41] studied the effect of biotin deficiency on the synthesis of serine from ethanolamine and bicarbonate *in vitro*, and on deamination and decarboxylation of serine by rat liver homogenate. They observed that the liver homogenate of normal rats utilised CO_2 from bicarbonate more efficiently in the synthesis of serine from ethanolamine than that of biotin deficient rats. This shows that this enzyme system is biotin dependent

Serine deaminase activity but not that of serine decarboxylase was also reduced in biotin deficiency.

Ascorbic acid

Hatwalne and Sohonie [42] studied the nature of indophenol reducing substances present in palm gur by chemical as well as by paper chromatographic method. The ascorbic acid value in palm gur as determined by chemical methods was due to a combined effect of true and "apparent" ascorbic acid. They further observed that 30 to 58% of the total value was due to non-specific reducing substances. The non-specific reducing substances in palm gur, as determined by the differentiation methods, were believed to be composed mainly of reductones. By paper chromatography they revealed the presence of four dye-reducing substances in palm gur. Two of these were identified as L-ascorbic acid and reductone, while the other two could not be identified. The same authors (Hatwalne and Sohonie [43]) isolated and purified dehydroascorbic acid reductase of neera from date palm. The purified enzyme preparations had an activity on dry weight basis of roughly 90-120 times that of the original neera. On nitrogen basis, the increase in activity was only nine-fold. The properties of the purified material indicated that dehydroascorbic acid reductase exhibited a maximum activity at pH 8.6, at 40°C., and when dehydroascorbic acid was 2 mg. and glutathione was 6 mg. in 10 c. c. of the reaction mixture. Cysteine and thiolacetic acid could not replace glutathione as hydrogen donor. The enzyme activity was not affected by KCN and H_2S, while complete inhibition took place with M/1000 sodium azide and very nearly so with the same concentration of iodoacetate. The purified enzyme preparation, when preserved at 0°C after lyophilization, retained its activity with slight variation for 16 days.

Chatterjee *et al.*[44] found that rat, mouse, rabit and goat liver homogenate as well as its extracts (obtained after the sedimentation of nuclear fraction and mitochondria) converted D-glucuronolactone into ascorbic acid in presence of potassium cyanide (5×10^{-2}M), the increase in the ascorbic acid content being 2-3 times that originally present in the tissue. Without cyanide such conversion did not occur. ATP, when used in concentration of 0.0016 M, was found to diminish the synthesis brought about by cyanide to the extent of 40-50%. They also observed that p-chloromercuric benzoate (1×10^{-3}M) and mercuric chloride (1×10^{-3}M) could inhibit this synthesis to a large extent. The presence of oxygen was apparently found necessary for the biosynthesis of ascorbic acid.

Three different types of feeding experiments were conducted to re-evaluate vitamin C therapy in fluorine intoxication in guinea-pigs (Venkateshwarlu and Narayanarao [45]). Fluoride ingestion did not influence the excretion and storage of vitamin C administered at three different levels. Similarly, vitamin C administered at various levels did not influence the retention and excretion of fluoride. In the third type of experiment an increased biosynthesis of vitamin C in the adrenals of fluorotic rats was noted compared to that in the adrenals of control ones, when animals in both the groups were fed scorbutic diet. This difference was not, however, perceptible when the animals received vitamin C therapy. Thus they were unable to show any relationship between vitamin C and fluoride metabolism.

Nath and Behki [46] studied the effect of the condensation product of glucose and acetoacetate and its hydrolysed product on the storage of diketogulonic acid (DKA), dehydro-ascorbic acid and ascorbic acid in rats. They observed less excretion of diketogulonic acid and ascorbic acid in animals injected with the sodium salt of the condensation product of glucose and acetoacetate than in unprotected animals. More diketogulonic and ascorbic acids and less dehydroascorbic acid were found in blood and tissues of protected animals than in the diabetic ones. The concentration of glutathione in blood was also examined after administration of dehydroascorbic acid. The condensation product, when given before dehydroascorbic acid, spared the depletion of GSH. The hydrolyzed condensation product when incubated with dehydro-ascorbic acid reduced it to ascorbic acid while the unhydrolyzed condensation product did not. On intraperitoneal injection of sodium acetoacetate (diabetogenic factor) to scorbutic guinea pigs Behki *et al.*[47] observed further decrease in the ascorbic acid content of the different tissues examined, the decrease being proportional to the amount of acetoacetate injected. On the other hand, there was a marked increase in the dehydroascorbic acid content of the tissues, which was practically absent in normal tissues. The glutathione contents of tissues of normal as well as scorbutic animals diminished as a result of acetoacetate injection.

Sarkar[48] reported on vitamin C content of *am~~o~~la*
/e m (*Phyllanthus ~~an~~blica*), guava and some varieties of green chillies grown in and around Darjeeling, at different altitudes. There was no relationship between vitamin C content and altitudes at which the fruits were grown. The vitamin C content of guava increased with the degree of ripeness.

Vitamin D

Pradhan and Magar[49] analysed some Indian shark-liver oils for their vitamin D content by biological and chemical methods in order to find out a correlation between the values obtained by the two methods. The oils from different species of sharks—*khada*, *pisori*, *waghbeer* and *win* assayed biologically gave only 5 to 15 I.U. of vitamin D per gramme. They were unable to apply the chemical method satisfactorily for vitamin D in corresponding oil samples.

Joshi *et al.*[50] found an increase in citrogenase activity, citric acid and total phosphorus content of the cartilage on oral administration of single large dose of vitamin D to rachitic dogs. At the same time, a rise in calcium, inorganic phosphorus and citric acid levels in serum was observed. That rachitic dog epiphyseal cartilage was almost incapable of synthesizing citric acid and that vitamim D treatment restored this ability was brought out by the authors.

Miscellaneous

Pai and Patel[51] examined the excretion levels of riboflavin and thiamine, before and after the test dose, in eleven healthy females ranging in age from 19-22 years selected from the nurses of the S.S.G. Hospital, Baroda. The average dietary intake of riboflavin and of thiamine by an individual nurse varied from 0.7 to 1.5 mg. and 0.8 to 1.7 mg. per day respectively. The average thiamine and riboflavin excretion in 24 hours collection of urine was 126.2 mcg. and 515 mcg., about 10 and 24 per cent respectively of the test doses. They (Pai and Patel [52]) extended this study further to obtain the values for urinary excretion of nicotinic acid also, besides thiamine and riboflavin, in another group of seven normal healthy female nurses. The thiamine and riboflavin excretion pattern was as above. The nicotinic acid excretion ranged from 1.02 to 6.51 mg. daily (average 3.24 mg.), which was about 10 per cent of the dose. No correlation was found between the percentage returns of any of these vitamins after test doses and the normal excretory levels of the vitamins in urine.

Bhattacharya [53] could not find any significant effect of feeding synthetic ascorbic acid on the high level of blood pyruvic acid in thiamine deficient rats. However, the tissue reserve of ascorbic acid in rats decreased in thiamine deficiency, and it could be replenished by feeding vitamin C to such animals. He has also recorded the average survival period of thiamine-deficient and of thiamine-deficient but ascorbic acid-fed rats.

Radhakrishnamurthy *et al.*[54] found that supplementation of l-cystine at 0.4 per cent level to the diet of rice moth larvae (*Corcyra cephalonica ST*) caused an inhibition of growth and increased accumulation of fat. D-L-tryptophane completely reversed both the conditions, whereas some of the B-group vitamins, such as nicotinic acid, vitamin B_{12} and choline were partially effective. Biotin, an anti-lipotrope, at 100 mcg. per cent level in the diet caused an inhibition of growth and increased accumulation of fat. This condition they could promptly reverse by supplementing the diet with 0.1 g. per cent of inositol.

Sathe *et al.*[55] investigated a possible relationship between the metabolism of thiamine, riboflavin and of estrogen in patients with oral cancer. They found gross deficiency of thiamine and moderate deficiency of riboflavin in patients with oral cancer, as judged from the urinary excretion of these vitamins before and after the oral administration of the test dose. On administration of the test doses of the vitamins, an increased excretion was noted in 15 out of 16 cancer patients. On the other hand, they observed decreased excretion of thiamine on administration of estrogens in 12 out of 16 cancer patients. A similar decrease in riboflavin was observed in 7 out of 16 patients. In normal controls the excretion levels of two vitamins were not altered by administration of estrogens. A probable relationship between the metabolism of these vitamins and of estrogens in cancer patients is indicated by the authors.

Mukherjee *et al.*[56] studied the effect of combination of vitamin E or vitamin K with estrogen therapy in alloxan diabetic rats. Among the different types of therapy tried by them, they showed that combination of vitamin K and estrogen was the most effective and the combination of vitamin E and estrogen was the least effective. When administered separately estrogen was found to be more effective in the treatment of alloxan diabetic rats than either vitamin K or vitamin E.

Chakravarti *et al.*[57] studied the effect of administration of ascorbic acid and vitamin B_{12}, alone and in combination, on preventing atheromatous lesions experimentally produced in rabbits by feeding cholesterol in olive oil for a period of twelve weeks. During this period, ascorbic acid and / or vitamin B_{12} injections were also given to different groups of animals. They reported that vitamin B_{12} alone or in combination with ascorbic acid, produced a greater degree of inhibition of atheroma than ascorbic acid alone. Vitamin B_{12} markedly increased free cholesterol and $\frac{\text{free cholesterol}}{\text{total cholesterol}}$ ratio in serum.

REFERENCES

1 Balasundaram, S., Cama, H. R., Sundaresan, P. R. & Varma, T. N. R. (1957), J. Sci. Industr. Res., **16C**, 8.

2 Roy, B. R. (1957), *Ibid.*, **16C**, 236.

3 Sastry, P. S, Krishnamurthy, S. & Ganguly, J. (1957), Indian J. Med. Res., **45**, 263.

4 Krishnamurthy, S., Sastry, P. S. & Ganguly, J. (1957), *Ibid.*, **45**, 391.

5 De, N. K. & Dikshit, P. K. (1957), Indian J. Med. Res., **45**, 71.

6 Cama, H. R., Pillai, N. C., Sundaresan, P. R. & Venkateshan, C. (1957), J. Nutrition, **63**, 571.

7 Bharucha, F. R. & Shankaranarayan, K. A. (1957), Sci. & Cult., **23**, 311.

8 Sastri, B. V. R, & Indravati, D. (1957), Indian J. Med. Res., **45**, 447.

9 Balakrishnan, S., Baliga, B. R. & Rajagopalan, R. (1957), *Ibid.*, **45**, 56.

10 Baliga, B. R., Balakrishnan, S., Bhagavan, H. N. & Rajagopalan, R, (1957), J. Sci. Industr. Res., **16C**, 152.

11 Bhagavan, H. N. & Rajagopalan, R. (1957), *Ibid*,, **16C**, 115.

12 Deolalkar, S. T. & Sohonie, K. (1957), Indian J. Med. Res., **45**, 771.

13 *Idem.* (1957), *Ibid.*, **45**, 587.

14 Lulla, B. S. & Johar, D. S. (1957), J. Sci. Industri. Res., **16C**, 45.

15 Banerjee, S. & Basak, R. (1957), J. Nutrition, **61**, 395.

16 Desai, D. B. & Chitre, R. G. (1957), Indian J. Med. Res., **45**, 461.

⑰ Chitre, R. G. & Raut, V. S. (1957), *Ibid.*, **45**, 457.

18 Das, M. L. & Guha, B, C. (1957), Sci. & Cult., **23**, 156.

19 Guha, B. C. & Das, M. L. (1957), Nature, Lond., **180**, 1285.

20 Das, M. L. & Ghosh, N. C. (1957), Indian J. Med. Res., **45**, 631.

21 Nadkarni, G. B. & Sreenivasan, A. (1957), Proc. Indian Acad. Sci., **46B**, 138.

22 Thangamani, A. & Sarma, P. S. (1957), Curr. Sci., **26**, 72.

23 Shenoy, K. G., Narayanan, M. S. & Ramasarma, G. B. (1957), Indian J. Med. Sci., **11**, 155.

24 Ghosh, S. R. & Datta, S. K. (1957), Indian J. Pharm., **19**, 96.

25 Joshi, M. R. & Sohonie, K. (1957), J. Sci. Industri. Res., **16C**, 68.

26 Shreenivasamurthy, V., Swaminathan, M. & Subrahmanyan, V. (1957), *Ibid.*, **16C**, 83.

27 Sivaramakrishnan, R. & Sarma, P. S. (1957), Curr. Sci., **26**, 283.

28 Altekar, W. W., Chitre, R. G, & Gokhale, S. K. (1957), J. Post Graduate Med., **3**, 193.

29 Nadkarni, G. B., Wagle, D. S. & Sreenivasan, A. (1957), Nature, Lond., **180**, 659.

30 Ganguly, S. K. & Bhattacharya, H. (1956), Indian J. Pharm., **18**, 361.

31 Nadkarni, G. B. & Sreenivasan, A. (1957), Proc. Indian Acad. Sci., **46B**, 236.

32 Narayanan, M. S., Shenoy, K. G. & Ramasarma, G. B. (1957), Nature, Lond., **178**, 1347.

33 *Idem.* (1957), Indian J. Med. Sci., **11**, 163.

34 Mulgaonkar, A. G. & Sreenivasan, A. (1957), Proc. Soc. Expt. Biol. & Med., **94**, 44.

35 Alimchandani, H. R. & Sreenivasan, A. (1957), Proc. Indian Acad. Sci., **45B**, 21.

36 *Idem.* (1957), *Ibid.*, **45B**, 27.

37 *Idem.* (1957), J. Bacteriol., **73**, 538.

38 *Idem.* (1957), *Ibid.*, **74**, 171.

39 *Idem.* (1957), *Ibid.*, **74**, 175.

40 Kasbekar, D. K. & Sreenivasan, A. (1957), Scientific Souvenir produced on the occasion of eighth annual conference of the Indian Association of

Pathologists & the Committee Meeting of The Indian Council of Medical Research, Pages 69—77.

41 Nadkarni, G. B. & Sreenivasan, A, (1957), Proc. Indian Acad. Sci., **46**, 229.

42 Hatwalne, B. V. & Sohonie, K. (1957), Ann. Biochem. Expt. Med., **17**, 45.

43 *Idem.* (1957), *Ibid.*, **17**, 53.

44 Chatterjee, I. B., Ghosh, N. C., Ghosh, J. J. Roy, R. N. & Guha, B.C. (1957), Sci. & Cult., **23**, 50.

45 Venkateshwarlu, P. & Narayanarao, D. (1957), Indian J. Med. Res., **45**, 377.

46 Nath, M. G. & Behki, R. M. (1957), Metabolism, **6**, 127.

47 Behki, R. M., Razdan, M. & Nath, M. C. (1957), J. Sci. Industr. Res., **16C**, 193.

48 Sarkar, S. R. (1957), Ann. Biochem, Expt. Med., **17**, 215.

49 Pradhan, S. K. & Magar, N. G. (1957), Indian J. Med. Res., 45, 49.

50 Joshi, J. G., Dikshit, P.R. & Patwardhan, V.N. (1957), *Ibid.*, **45**, 439.

51 Pai, M. L. & Patel, T. V. (1957), J. Obstr. Gyn. India, **7**, 176.

52 *Idem.* (1957), *Ibid.*, **8**, 166.

53 Bhattacharya, K. R. (1957), Ann. Biochem. Expt. Med., **17**, 5,

54 Radhakrishnamurthy, R., Sivarama Sastry, K. & Sarma, P. S. (1957). J. Sci. Industr. Res., **16C**, 221.

55 Sathe, V. R., Talageri, V. R., Khanolkar, V. R. & Panse, T. B. (1957), Indian J. Med. Res., **45**, 401.

56 Mukherjee, S. K., De, U. N. & Mukerjee, B. (1957), *Ibid.*, **45**, 23.

57 Chakravarthi, R. N., De, U. N. & Mukerjee, B. (1957), *Ibid.*, **45**, 315.

GENERAL MICROBIOLOGY INCLUDING ANTIBIOTICS

F. FERNANDES, J. M. D'SOUZA & A. VAZ
St. Xavier's College, Bombay

In the field of microbiology, research progress has been quite satisfactory in India. Even though the impetus for microbiological research in this country is not what it really should be, a survey of biological research during the last decade clearly indicates that this subject has been progressively drawing the attention of more and more scientists. It is also apparent that several Indian workers having had their basic training in different scientific disciplines are finding microbiology a virgin and profitable field both for fundamental and applied investigations. As in the past, during this year also a large number of research contributions in microbiology has been, as naturally should be, in the field of microbial biochemistry and antibiotics. It is further encouraging to note that in a predominantly agricultural land like ours, soil microbiology including plant pathology is fast gaining its prominence.

Fundamental Studies on Microorganisms

Continuing their studies on *Saccharomyces carlsbergensis*, Thyagarajan and Subramaniam[1] have dealt with the nucleus and its structural details. In the staining procedure, iodine-formaldehyde-acetic acid has been recommended as it gave a life-like preservation of the cell structure. Tintometric values of haematoxylin and Feulgen stains have been indicated. The nucleus in the zygotes, it is observed, becomes visible on the 7th day after the introduction of the spores into the fresh wort and its structure is identical both in the zygote and its bud. Sharma and Shukla[2] studied the development of drug resistance in *Saccharomyces cerevisiae*. Employing gentian violet and gerefak they observed the emergence of a resistant strain when the culture of the yeast was passaged several times in a standard medium containing an appropriate amount of the inhibitor. This impressed variation is apparently of a transient nature since the adapted strain partially loses its dye-resistance when subcultured several times through a dye-free medium. Working with the dye adapted strain the authors further record the development of two distinct type of colony forms, when grown on White and Munn's agarified medium.

Three new species of fungi, identified as *Pseudocercospora gomphranicola* sp. nov., *Pseudocercospora daturae* sp. nov. and *Arthrobotryum glochidii* (Peteh) var. *lanceolaris* var. nov. encountered in the vicinity of Poona and Mahabaleshwar, have been described by Chiddarwar.[3] Working with spores of a strain of *Aspergillus niger* which normally took about 8.5 hours to germinate, Bose [4] has noted a progressive delay in the period of their germination, when exposed to phenylmethane dyes like crystal violet, methyl violet and malachite green, which ultimately attains a constant value quite independent of the duration of exposure. He, however, notes that the viability count is progressively diminished until the organisms are completely destroyed. Germination, it is concluded, apparently follows more than one pathway. Banerjee *et al.*[5] have described the nucleus of *Trichophyton rubrum* during the various stages of its development as visualised by the special stain termed the M. R. stain and Feulgen technique. During the course of cytochemical studies, the early difficulties encountered in observing the nucleus of the fungus were solved by treatment with alkali-alcohol prior to subjecting the microscopic fungal preparation to Feulgen reaction. A rapid method for making permanent stained preparations of faecal smears for protozoa, based on the principle of combining the stain with the fixative, so that the nucleus, cytoplasm and other inclusions, such as the chromatoid bodies would be stained differentially has been developed by Mukherjea *et al.*[6] This stain previously referred to as M. R. stain was further modified by Mukherjea and Ray,[7] by substituting eosin for acid fuchsin. This gave satisfactory results when used in the study of intestinal protozoa as well as trypanosomes. The authors further find this stain useful for the demonstration of the cytological features of such parasitic fungi like *Trichophyton rubrum* and *Epidermophyton flocusum.*

A suitable method for the demonstration of mitotic stages in the vegetative hyphae of *Psalliota campestris* and *Polyporus cuticularis* has been described by Bose.[8] The hymenomycetes were grown in 3 per cent malt medium. Based on the observation that aesculin and saponin in the cold helped the easy penetration of the fixing fluid through the chitinous walls of the higher fungi, Fleming's strong fluid preceded by pretreatment at 15°C to 16°C for 1½ hours with aesculin, 1 per cent saponin, acetorcein and Feulgen stain was advantageously used in the staining process.

In an extensive study of 23 species of the genus *Fusarium* obtained from Holland, Venkata Ram [9] observed that in addition to the species already reported, *Fusarium orthoceras* App. et Wr· was capable of producing appreciable quantities of fusaric acid *in vitro*. The biosynthesized toxin excreted in Richard's medium was identified by paper chromatographic determination of its R_f values in known solvents. The fungus is reported to have produced 300 mg/L of fusaric acid as compared to *Fusarium muniformi* and *Fusarium vasinfectum* which produced only 65 mg/L and 35 mg/L of fusaric acid respectively. Lakshmanan and Venkata Ram [10] have tested culture filtrates of 21 species of Fusarium for their action on cotton tissue respiration. While 4 species inhibited the respiratory rate, all the rest, with the exception of 3, elicited high increase in tissue respiration as compared to the control. Lakshminarayanan and Subramanian [11] have described a suitable method for the chromatographic detection and estimation of fusaric acid. The toxin is converted into a copper chelate and identified on Whatman No. 1 paper by circular chromatographic method.

Working with a strain of *Penicillium vermiculatum*, Das Gupta and Nandi[12] have confirmed the common observations that high concentrations of nitrogen in the medium hinder sexuality of the fungi. Concentration above 0.1 per cent of sodium nitrate was found antagonistic to sexual reproduction of the fungus. Studying the oxygen transfer in submerged fermentation of *Penicillium chrysogenum*, Gondhalekar and Phadke[13] have correlated higher penicillin titres with higher mycelium content, as well as higher oxygen diffusion rates. A top yeast mutant BY2 isolated by earlier workers was studied in detail by Mitra[14] who recommends a new taxonomic position to this mutant basing essentially his arguments on its constitutive capacity to synthesize considerable amount of riboflavin under cultural conditions. The name *Candida ghoshii* after Professor J. C. Ghosh, has been proposed to this yeast mutant.

Khambata and Bhat[15] employing five selective enrichment media along with two routine media have carried out a systematic analysis of the intestinal contents of 60 earthworms sampled during the monsoons over a period of four years. The heterogenous microbial spectrum represented by 343 isolates has been studied in detail with respect to the physiological activities, such as oxalate decomposition, cellulose decomposition, nitrogen fixation and asparagine utilisation. These findings are discussed in relationship to soil fertility. It is observed that the normal intestinal microbial spectrum of the earthworm consists mainly of Pseudomonas, coryneform bacteria, Nocardia, Streptomyces and spore forming bacilli. Surprisingly the mineralising species of bacteria do not appear to be associated with the intestine of the earthworm. The probable role of this coelentarate in the spread of phytopathogens as Fusaria has been indicated. The earthworms, it is concluded, play an important role in soil fertility.

In an attempt to shorten the period of incubation of *Mycobacterium tuberculosis* H_{37} Rv strain, grown as surface culture in Youmans's medium, Ramakrishnan *et al.*[16] utilised the water of tender coconut and found that it reduced the optimum growth yield period considerably even when used in such high dilutions as 1 : 10,000. The substance responsible for this enhancement of growth has been identified as a polysaccharide. Working with 153 strains of acid-alcohol fast Mycobacteria from human sources, Ganguli [17] has correlated the neutral red test with the classical *in vivo* guinea-pig virulence test. Out of these all the 143 strains of *Mycobacterium tuberculosis* developing typical tuberculous lesions in experimental guinea-pigs yielded a positive neutral red test while 8 of the remaining 10 strains found non-pathogenic to guinea-pigs were found neutral red negative. The author finds that this reaction applies as well to saprophytic Mycobacteria and Nocardia.

Shukla and Prabhu [18] have summarised their observations on the microbiological examination of Indian sugars. From a study of 424 cultures of bacteria isolated from sea water, Sreenivasan [19] points out to the nitrate reducing generic trait of the marine Pseudomonas. Among the cultures studied, 93 per cent of the Pseudomonas, 57.5 per cent of the Micrococci and 42 per cent of the aerobic spore bearing bacilli are classified as denitrifers. Majumdar and Padma [20] have reported their observations on the sporulation of bacilli in a fluid medium under the influence of various carbohydrates, while Iyengar and Ganju [21] have referred to the biological effects of radioactive phosphorus on *Phycomyccs blackesleeanus*. Burg. Whilst assaying skim milk powder samples for orotic acid employing *Lactobacillus bulgaricus* 09, the presence of a substance inhibitory to the growth of this organism was detected in the sample stored at 60°C for 6 months, by Visvanathan and Sarma.[22] Over-heating as well as autoclaving at 15 lbs. pressure induces the formation of this inhibitor in the skim milk powder. By paper chromatographic methods this inhibitor has been recognised as a peptide. It has been obtained in a concentrated form by extraction with ether preceded by extraction with acetate buffer at pH 4.5. It causes complete inhibition of growth of *Lactobacillus bulgaricus* at levels between 200 γ to 400 γ per ml. of the medium.

In the course of his studies on the action of phenols on cultures of *Vibrio cholerae*, Bhaskaran [23] observed that menthol, resorcinol, catechol and carbolic acid do not lyse the cultures of the cholera organism as easily as thymol does. 50 mg/10 ml. of culture of thymol causes a complete lysis of a four hour broth culture of *Vibrio cholerae* in 30 to 45 minutes at incubation temperature. On account of the low toxicity of thymol the author envisages the therapeutic potentialities of this vibriolytic phenol. Employing the well known ammonium sulphate precipitation and solvent fractionation methods along with gel diffusion technique, Bhagawan *et al.*[24] have attempted to characterize the antigenicity of ***Pasteuralla pestis***. A new technique for the viable count of bacteria has been described by Guha.[25] Tetrazolium salt is used on the assumption that the mitochondria of living bacteria would reduce the salt resulting in the formation of red formazan particles, as a result of the characteristic enzymatic activity naturally lacking in dead bacteria. Living bacteria under the microscope were observed to have a reddish tinge in contrast to the dead cells which appeared completely transparent.

A survey of viruses by Bose [26] refers in a general manner to the cytological, chemical and chemotherapeutic aspects of phytopathogenic and zoopathogenic viruses. In doing so the author has tried to bring out some of the unsolved problems related to the study of viruses. On the basis of egg inoculation as well as laboratory animal tests Murti and Shrivastava [27] have postulated the possible existence of different strains of variola virus. With an absorption maxima and minima at 2,600 A° and 2,300—2,500 A° units respectively, the nucleoproteins of bacteriophage were found by Banerjee and Roy [28] to resemble closely those of yeast nucleic, ribonucleic and desoxy-ribonucleic acids.

Nutrition and Biochemistry of Microorganisms

Escherichia coli mutant 301 has been successfully used by Ghosh and Dutta [29] for the purpose of assay of vitamin B_{12}. The paper deals with the method of assaying cyanocobalamine content of preparations which might contain other growth factors. Deacidite F. F. was used in the hydroxide form in order to absorb and eliminate these factors. Vitamin B_{12} in the percolate was assayed microbiologically using *Escherichia coli* mutant 301. Parallel spectrophotometric estimations confirmed the validity of the strain. Alimchandani and Sreenivasan [30] have reported the inhibitory effect of an oxidation product of Vitamin B_{12} on the growth of *Escherichia coli.* Such substances as yeast extract, peptone, crushed cell extract of *Escherichia coli* as well as a mixture of amino acids were found to neutralize to an appreciable extent this inhibitory effect. The amino acids however when tried individually were found inactive. Alimchandani and Sreenivasan [31] observed that the action of penicillin on the growth and on the pentose nucleic acid synthesis in *Lactobacillus casei* could be reversed by folic acid or more effectively by folic acid and vitamin B_{12}.

The feasibility of employing *Torula glabrata*, a marine yeast for assaying microquantities (5 to 40 mug) of thiamine has been suggested by Ranganathan and Sastry.[32] The effect of continued feeding of curds as against feeding synthetic thiamine, along with sulphaguanidine administered in alternate weeks, on the intestinal flora and biosynthesis of thiamine in rats was studied by Balakrishnan *et al.*[33] Sulphaguanidine brought about a drastic reduction in the synthesis of thiamine followed by a considerable fall in the body weight of experimental rats resulting in the death of some of them when they were fed on synthetic thiamine, whereas rats fed on curds alone or curds with synthetic diet were not appreciably affected by sulphaguanidine as judged in terms of thiamine synthesis or relative intestinal coliform count. Subrahmanyan *et al.*[34] have observed the effect of garlic in the diet, on the intestinal microflora of rats. The administration of garlic at therapeutic levels along with the diet, reduced considerably the number of coliform bacilli and intestinal amoeba. The supplementary value of banana to a poor rice diet and its influence in thiamine synthesis in rats was studied by Bhagawan and Rajagopalan.[35] The authors obtained a favourable growth response and further observed that banana in the diet improves the liver storage of thiamine. Banana has been reported to effect a favourable change in the intestinal flora by several workers. The improvement of rats under experimentation was attributed partly to the intestinal synthesis of thiamine.

The production of riboflavin by *Erymothecium ashbyii*, employing such substrates as wheat and rice bran, malted barley, ragi, oilseed cakes, tapioca, potato flour and lucerne meal has been investigated by Lulla and Johar.[36] The authors found wheat and rice bran the best substrates for the biosynthesis of the vitamin. A method for its producation and concentration employing wheat bran as substrate has been described.[37] Using a strain of *Aspergillus niger* N.C.T.C., Poona, Sastry and Sarma record the enhancing effect of glucuronic acid on the synthesis of ascorbic acid.

In the course of their studies on sulphonamide action *vis a vis Escherichia coli* metabolism, Alimchandani and Sreenivasan,[38-40] utilising several metabolites functionally related to para amino benzoic acid, (PABA) have studied the reversal of sulphadiazine growth inhibition in the Macleod strain of this organism. They observe that vitamin B_{12} and glycine, to a lesser extent threonine, are essential (in addition to the known combination of methionine, xanthine, valine, etc.) to obtain reversal at high concentration of sulphadiazine action. Substitution of xanthine by a mixture of purines together with the above mentioned metabolites gave a reversal of growth inhibition comparable to that produced by PABA. The action of threonine was attributed to the ability of *Escherichia coli* to convert it to glycine. The sulphonamide, it is pointed out, blocks the biosynthetic mechanism for glycine-serine interconversion. Folic acid or leucovorine were found inactive in reversing sulphdiazine growth inhibition or in replacing any of the sulphadiazine reversing metabolites even in the presence of excess of B_{12}. They observe that homocysteine or homocystine could not replace methionine even in combination with B_{12}. The authors have presented evidence to indicate that the cells of *Escherichia coli* are impermeable to pteroylglutamic acid or leucovorine, found inactive in overcoming sulphonamide growth inhibition or in influencing amine accumulation. Vitamin B_{12} and methionine at identical concentration depress the accumulation of 4-amido-5-imidazole carboxamide to different degrees, vitamin B_{12} being more effective than methionine. The authors state that the primary effect of vitamin B_{12} or methionine is on those aspects of cell metabolism that are interfered with by sulphonamides. The influence of B_{12} on the conversion of amine to purine is indirect. Further, the inability of an *Escherichia coli* mutant to accumulate the amine under conditions of deficiency of vitamin B_{12} or methionine is in favour of the above observation that the two metabolites under question are involved only indirectly in purine synthesis.

Quantitative paper chromatographic analysis of the amino acid composition of strains of *Penicillium chrysogenum* and *Aspergillus oryzae* grown in synthetic, as well as, complex media has been carried out by Datta *et al.*[41] Practically all the essential as well as commonly occurring non-essential amino acids have been found in the samples analysed. *Penicillium chrysogenum* was found to yield a higher percentage of nitrogen when grown in a synthetic medium. The nitrogen value of *Aspergillus oryzae* grown in this medium is slightly higher as compared to those of the two fungi grown in the non-synthetic medium. The influence of carbohydrates on growth and sporulation of some anthracnose fungi has been elucidated by Grewal [42] whilst Krishnan *et al.*[43] have studied some of the factors leading to the formation of soluble and insoluble metaphosphates in *Aspergillus niger.* Analysing the crystalline alpha amylase isolated from culture filtrates from *Aspergillus oryzae,* Roy [44] has reported the absence of inositol in the diastase. Working with *Penicillium viridicatum* Westling, Sankhala [45] has isolated from its metabolic solution by ethyl acetate extraction cyclopolic and cyclopaldic acids. The author has attempted to solve certain taxonomic problems related to this group of fungi.

Investigating the process of *in vitro* lipase synthesis in *Aspergillus niger,* Ramakrishnan [46] indicated the possible role of amino acids like cystine, methionine, valine, glutamic acid, etc. in the synthesis of this enzyme. The effect of inorganic salts and buffers at different levels of concentration on fat synthesis in cultures of *Penicillium aurantiobrunneum* was studied by Singh and Singh.[47] A maximum concentration of 20.6 per cent fat was observed when the organism was grown in a medium containing 0.45 gms of ammonium nitrate, 0.088 gms of potassium sulphate, 0.25 gms of magnesium sulphate and 0.73 gms of sodium dihydrogen phosphate per 100 ml. of the medium. Singh and Dutt [48] investigating the optimum carbohydrate requirements of *Aspergillus nidulans,* observe that while 20 per cent sucrose in a synthetic medium yielded maximum fat, 40 per cent sucrose gave the least yield. The component fatty acids of the semi solid fat elaborated by *Aspergillus flavus* grown in a medium containing sucrose and inorganic salts were studied by Singh.[49] The close resemblance of this fat to animal fat has been reported.

The utilisability of six p-aminobenzoyl peptides by *Streptococcus faecalis* R and *Lactobacillus arabinosus* 17-5 A.T.C.C. No. 8014 was studied by Pal *et al.*[50] They observed that the synthetic peptides could not replace the corresponding amino acids, except that *Streptococcus faecalis* could utilize p-aminobenzoyl-methionine to a larger extent and *Lactobacillus arabinosus* could utilize p-aminobenzoyl-alanine to a smaller degree.

The nutritional requirements and in particular the amino acid requirements of the *Lactobacteriaceae*, including 20 streptococci and 11 lactobacilli representing different species and strains isolated from curds and including some type cultures were studied by Gonsalves *et al.*[51] Arginine, glutamic acid, leucine, isoleucine, trytophane and valine were found essential for both streptococci and lactobacilli. Though all streptococci required histidine and methionine they differed in their demands for alanine, serine and threonine. Tyrosine was found essential for all lactobacilli while methionine and phenylalanine for most of them. *Lactobacillus casei* needed essentially proline for its growth. The vitamin requirements of 57 cultures of lactic acid bacteria including streptococci, leuconostocs and lactobacilli have been reported by Nambudripad *et al.*[52] It is observed that the streptococci were exacting in their requirements for pantothenic acid, pyridoxine and biotin while thiamine, p-aminobenzoic acid and cyanocobalamine were found non-essential. On the other hand, the streptococci exhibited a marked variation in their demand for folic acid and pyridoxine. Leuconostocs required pantothenic acid, pyridoxine, nicotinic acid and biotin for their growth while p-aminobenzoic acid and cyanocobalmine had no influence on it. Studies with lactobacilli indicated their less exacting nature with regard to vitamin requirements as most of the strains required only riboflavin, pantothenic acid nicotinic acid and biotin for initiation of growth.

The effect of different condiments, such as aniside, asafoetida, black pepper, chillies, cinnamon, cloves, ginger, etc. on the growth of *Aspergillus niger* in mango pickles was investigated by Anand and Johar.[53] Most of the spices except cinnamon and cloves had little or no inhibitory effect on this mould. Sodium chloride in concentration used in the pickle, although not effective in itself was found to supplement the preservative effect of cinnamon and cloves. The fungistatic nature of essential oils from condiments and their preservative value in pickles were pointed out.

Studying the oxidative metabolism of both avirulent and virulent strains of *Pasteurella pestis*, utilising 5 amino acids and

3 sugars, Shrikantan *et al.*[54] have demonstrated the lack of general correlationship between virulence and oxidative metabolism in the above pathogen. Old cultures of plague bacillus showed significantly low oxygen consumption in the presence of glucose, ribose and serine. Though the tetracyclines considerably inhibited both glucose and serine metabolism, neomycin, streptomycin and chloromycetin only slightly inhibited serine metabolism while activating glucose oxidation. On the other hand the sulphonamides had no effect. The transamination reaction with the cell-free extracts of the virulent and avirulent strains of *Pasteurella pestis* studied by Saxena *et al.*[55] did not likewise show a general correlation between virulence and transamination. Among the compounds tested, mercuric sulphate showed the maximum inhibition while both the antibiotic and sulpha drugs had no effect.

Medical Microbiology Including Antibiotics

Surveying the problem of amoebiasis and the available amoebicides, Popli and Mukerji[56] have attempted to formulate a working hypothesis with an object to suggest certain possible courses that could be beneficially pursued for enhancing the therapeutic value of amoebicides. Kaushiva[57] has carried out a comparative study of the sensitivities of *Entamoeba histolytica* and 3 free living amoebae, *Naggleria gruberi*, *Schizopyrenus russelli* and *Didasculus thorntoni*, to the action of standard amoebicidal compounds with an object to select the simple free living amoebae for the purpose of screening amoebicidal compounds. It has been observed that free living amoebae show a somewhat parallel behaviour in their response to various compounds tested but their amoebicidal end points are in general different as compared to *Entamoeba histolytica.* Working further on the technique for the screening of amoebicides, Ray *et al.*[58] recommended the use of sealed culture tubes since studies with Mysteclin showed that atmospheric oxygen interfered with the proper assessment of the drug. As potential amoebicides Gopalchari[59] has described the synthesis of some 4-substituted aminomethyl-5-chloro-8-methoxyquinolines. Working along the same lines Iyer *et al.*[60] described the synthesis of some 3-alkyl-8-hydroxy and

8-methoxy-3 : 4-dihydroquinoazolines. As amoebicidal agents, β-phenylethylamines are observed to be more active than α-phenylethylamines by Kaushiva.[61] A crystalline bismuth iodide complex of the total alkaloids of *Cephalis ipecacuanha* has been prepared by Bhattacharya and Basu.[62] The preparation was used in the treatment of intestinal amoebiasis with satisfactory results. Basu Roy and Nandy,[63] Krishnaswamy and Vaidyanathan,[64] as well as Sarin and Das Gupta [65] have reported their observations on the therapeutic value of amoebicides.

Chopra *et al.*[66] have studied the antimicrobial activity of volatile principles from *Alpinia galanga* and *Acorus calamus* against protozoa and bacteria, including *Mycobacterium tuberculosis.* The activity of the oil of *Alpinia galanga* tested against the human, avian and bovine strains of tubercle bacilli, showed complete inhibitory range between 25 μg/ml. to 30 μg/ml. Besides the activity against the *Salmonella*, *Shigella*, *Escherichia* and the *Vibrio* was of a high order. The essential oil from the rhizomes of *Acorus calamus* was especially active against *Mycobacterium tuberculosis* in concentrations ranging from 10 μg/ml. to 12 μg/ml. Testing the alcoholic extracts of *Cassia tora* seeds and *Cassia obovata* leaves Patel and Patel [67] report a vide range of activity against the Gram-positive and Gram-negative organisms. Comparative studies were carried out with penicillin sodium and dihydrostreptomycin sulphate. Similarly, Patel and Trivedi [68,69] have tested the aqueous and alcoholic extracts of the dry pulp of the fruits of Colocynth. The extracts were found active against a representative number of Gram-positive and Gram-negative organisms. Studies along the same lines with *Enicostema littorale* have yielded interesting results. The kinos of 4 Eucalyptus species have been analysed by Satwalekar *et al.*[70] for their physical, chemical as well as antibacterial activities. Of these the kino of *Eucalyptus citriodora* showed potent activity against Gram-positive organisms. The antibacterial principle ' citridorol ' has been isolated.

Subramanyan *et al.*[71] have recorded high antibacterial activity of garlic. The spice was found active against *Escherichia coli*, *Aerobacter aerogenes*, *Staphylococcus aureus* and *Shigella* *dysenteriae* var. sonne. It is of interest to note that the extract is not active against *Lactobacillus casei.* Utilising *Curvularia lunata* and *Aspergillus niger*, Chakraborty *et al.*[72] have tested 17 natural coumarins for their antifungal properties. Of these, psoralin, seselin, luragetin and xanthyletin were found to show pronounced action against *Curvularia lunata.* In order to obtain an insight into the structural relationship and antibacterial activities of the compounds related to pterygospermin and benzylisothiocyanate, Das *et al.*[73] have tested a few naturally occurring glycosides and other compounds related to the isothiocyanates. Subrahmanyan *et al.*[74] observed that the inclusion of the drum dried banana powder in synthetic or rice diet resulted in lower absorption of nitrogen and threefold increase in faecal weights. The significance of these experiments has been discussed in the light of earlier reports on the therapeutic properties of banana in diarrhoeal conditions.

In a systematic survey of the available literature concerning the biosynthesis of penicillin, Ganapathi [75] has attempted to formulate a working hypothesis to explain the possible course of events leading to the biosynthesis of benzylpenicillin from its precursor, by *Penicillium chrysogenum.* In a later publication, Despande and Ganapathi [76] refer to the enzyme systems involved in the biosynthesis of benzylpenicillin. Dealing with the production of phenoxy-methylpenicillin, Ghosh and Guha,[77] having found yeast autolysate an expensive constituent for the production of antibiotic in India suggest a medium consisting of mustard oil cake, sesamum oil cake along with other constituents as a cheap and economic substitute.

In the course of their survey of soil actinomycetes Dhala and Bhatnagar [78] analysing at random 38 soil samples from different parts of India have isolated 153 Actinomycetes. Tested for their antibiotic activity, 49.02 per cent of them produced antibiotics when grown in liquid media. Freshly manured soils are recorded to have yielded the highest percentage of antagonistic Actinomycetes. *Stretomyces flavus* group predominates in Indian soils. Dhala *et al.*[79] have described a new species of Streptomyces possessing both antibacterial and antifungal properties. The organism termed *Streptomyces caiusiae*, belongs to the chromogenic Streptomyces antibioticus group. Vora *et al.*[80] have isolated an antibiotic termed 'X 340' from an unidentified species of Streptomyces. The antibiotic is active against a large variety of microorganisms. Its chemical nature including the microanalytical and infra red absorption data have been presented.

Dealing with antibiotics from *Fusarium avenaceum*, Tirunarayanan and Sirsi[81, 82] have studied the antibiotic termed Enniatin B. This antibiotic which is mainly intramycelial in character does not appear to be inactivated by moderate concentrations of whole blood, gastric extract and differences in pH. Cultural conditions for the optimum yield of the antibiotic are described. Referring to the mechanism of its antibacterial action, the authors indicate that the effect of the antibiotic manifests through the interference with the metabolism of inositol and choline. Enniatin B possesses a high antitubercular activity. The growth of $H_{37}Rv$ strain of *Mycobacterium tuberculosis* is inhibited in dilutions upto 1×10^{-7}. Administered intraperitoneally in a dosage of 100 mg/kg daily it arrests the progress of experimental tuberculosis in mice. The activity as reported is however of a lower order as compared to dihydrostreptomycin.

The effect of antibiotics on staphylocoagulase and staphylophosphatase producing power of micrococci has been studied by Rangam and Manjrekar.[83] Working with 73 strains of staphylococci, the authors observe that penicillin and chloroamphenicol individually inhibited both the enzymes. It is concluded that phosphatase and coagulase tests cease to be reliable pathogenicity tests for identification of virulent staphylococci originating from patients treated with these antibiotics. Rangam *et al.*[84] in their attempts to explain the influence of chloroamphenicol on the agglutinable titre of sera from cases of typhoid fever, treated with this antibotic, note a reduction in the titre of the serum caused by a physical union between the antibiotic and the specific antibodies through absorption. Shah *et al.*[85] having utilised Tebafan (GT_3) in the treatment of 67 cases of pulmonary tuberculosis refer to the usefulness of this therapeutic agent particularly when used in combination with streptomycin. Gupta and Mathur[86] have investigated the therapeutic activity of the two sulphones, S. N. 44 and S.N. 47. From the mice protection studies the authors observe that the two sulphones possess significant antitubercular activity. The therapeutic activity of Nystatin (Mycostatin, Squibb) has been investigated by Pohowalla *et al.*[87] The antibiotic has been found useful in the treatment of moniliasis in children.

Studying the glomerular filtration rate and renal plasma flow in cholera and acute gastroenteritis patients, Banerjee and Ghosh [88] attribute the cause of diminished kidney function to renal anoxin rather than to the specific toxin of the pathogens. Banerjee *et al.*[89] analysing 73 cases of gastroenteritis in various age groups including infants, were able to demonstrate the presence of several serological types of *Escherichia coli*, in particular *Escherichia coli* serotype 026. Phage typing of *Vibrio cholerae* isolated from Calcutta epidemics was carried out by Mukerjee *et al.*[90] From the stools of cholera patients 30 bacteriophage strains were isolated and classified into 4 groups. With these, the 200 stains of *Vibrio cholerae* secured from the locality, have been differentiated into 7 types and subtypes. The possible role of cholera bacteriophage in the genesis of cholera vibrio types has been suggested. Continuing their studies in cholera infection and immunisation, Guha *et al.*[91] record their failure to demonstrate the presence of detectable antigenic constituents of *Vibrio cholerae* in the blood of acute cholera patients, as judged by the absence of specific precipitinogens. Banerjee *et al.*[92] subsequent to their studies on glucose tolerance test in cholera have recommended intravenous administration of glucose to cholera patients. Working on the bacteriophage of *Shigella dysenteriae* var. Shiga, Banerjee and Roy [93] observed that an increase in the organic phosphates in the culture filtrates of the organism could be associated with the corresponding synthesis of bacteriophage nucleoproteins. A report on the summer diarrhoea in children at Jaipur, by Sarin *et al.*[94] records the predominance of Shigella and Salmonella group of organisms. It has been pointed out that *Pseudomonas aeruginosa*, *Proteus vulgaris* and *Streptococcus faecalis* are also responsible for diarrhoeas.

Roy and Banerjee[95] have described haemagglutination and Mantoux tests for the detection of humoral antibodies in the sera of leprosy patients and the skin sensitivity respectively. No correlation between these two immunological reactions has been observed. Chatterjee *et al.*[96] have recorded their findings on the histological studies on skin lesions in lepromatous leprosy.

A virulent strain of ranikhet disease virus was found by Babbar and Dhar[97] to become avirulent to chickens when treated *in vitro* with adenylic acid. While administration of adenylic acid within one hour of infection protected the fowls, its administration 6 to 18 hours after infection did not alter the course of the disease. Bhatt and Work[98] have reported their findings on the tissue culture studies on Arbor viruses in chick embryo and monkey kidney cells. Soman and Nimbkar[99] have presented their cultural and serological observations on 115 influenza virus strains. Certain immunological and epidemiological aspects of the problem have been discussed.

Employing paper electrophoresis procedure the analysis of plasma proteins from representative cases of cholera, tetanus, meningitis and small-pox, has been carried out by Banerjee and Chatterjee.[100] In comparison to normal persons, variations in the contents of albumin, globulin and fibrinogen of the serum have been observed and their significance to immunological procedures has been discussed. Studying the amino acid composition of the smooth and rough forms of certain serotypes of *Escherichia coli*, Banerjee[101, 102] has described the occurrence of marked quantitative variation in the amino acid contents of individual strains. The variations of the protein and amino acid content in the smooth and rough type of *Escherichia coli* have been correlated to the DNA contents. In their attempts to compare the biological property of the Ty 0-901 strain of *Salmonella typhosa* to its chemical composition. Saha *et al.*[103] note that different antigens extracted, differed both in their composition and biological function. Among the reagents used for extraction of the somatic antigens trichloracetic acid gave the best extracts of the bacterial constituents. On the basis of lactose utilisation by *Escherichia coli*, Chatterjee *et al.*[104] have reported their findings on the effect of antiserum on bacterial adaptation. Darekar and Jhala [105] have reported their observations on the evaluation of Price's precipitation reaction in the sero-diagnosis of syphilis. In a series of articles titled 'Modern practice in Immunisation', Banker [106-112] has surveyed the various problems concerning prophylactic immunisation against diseases towards which active immunising agents exist. Effect of ultra violet radiation on bacterial antigens and virulence has been studied by Mukherji.[113] Some information on the microbiology of air is available from the studies conducted at Army Medical Campus, Poona, by Kolra and Dumbrey.[114] Working with *Leishmania donovani*, Chatterjee and Ghosh [115] have demonstrated strong transaminase activities in the cell free extracts of the organism cultivated on Roy's medium.

Soil Microbiology including Plant Pathology

A new biotype of *Fusarium oxysporum* Schlecht. f. pisi (Linford) Snyder and Hansen, race 1, has been described by Sukapure *et al.*[116] The fungus causes serious wilt disease of *Pisum sativum* L. (Pea) in North Satara district. Rolling and drooping of leaves is the first noticeable symptom, starting from the oldest leaves the entire plant wilts. The authors have described certain biological characteristics of the fungus with regard to its pathogenecity; further they note that all wilt resistant American and Dutch pea varieties were susceptible to this fungus. Chattopadhyay and Basu [117] attribute the wilt disease of *Abelmoschus esculenthus* (Bhendi) seedlings to *Fusarium solani* (Mart) App. and Wr. emend Snyder and Hansen. The authors describe their findings of inoculation and pathogenecity tests. Experiments carried out to correlate the intensity of infection to soil types showed that while infection is favoured by medium to heavy texture of soil, light soil does not present a suitable condition for the growth of the fungus.

Bedi [118, 119] has studied the effect of solar heat in the control of loose smut of wheat and barley. It has been shown that after a pre-soaking period of 4 hours in water of seed wheat, exposure to one hour's solar heat was found enough to devitalize the intra-seminal mycelium of the loose smut fungus, *Ustilago tritrici*.

Exposure of soaked wheat to sun's rays even for 5 minutes or even the mere process of soaking the seed wheat in ordinary water at room temperature and shade drying resulted in an appreciable reduction of infection. Soaking naturally infected barley in water for 4 hours and subsequent direct exposure to sun's rays for about 6 hours was found to eliminate effectively the loose smut infection due to *Ustilago nuda* (Jens.) Rost. This treatment was found harmless to the viability of the treated seed. Two new physiological races of *Puccinia triticina* Eriks. (brown rust) and *Puccinia graminis tritici* (Pers.) Eriks and Henn (black rust) have been encountered for the first time as pathogens on wheat by Vasudeva *et al.*[120, 121] A new rust on the leaves of *Garcinia indica* due to an *Aecidium* species has been described by Sundaram and Venkata Rao.[122] A report of a rust *Puccinia kuehnii* (Krueg) Butler, on *Erianthus munja* has been made by Sharma.[123]

A leaf blotch disease on *Rauvolfia serpentina* Benth, was diagnosed by Chandra [124] to be due to *Cercospora* species. A pathogenic fungus, morphologically, culturally and physiologically related to *Alternaria ricini* (Yoshii) Hansford, has been described as responsible for leaf spot disease of *Riccinus communis* (Castor) by Pawar and Patel.[125] *Neottiospora curcumae* sp. nov., has been described by Ramakrishnan and Sundaram [126] as the pathogen responsible for extensive drying of the leaves of *Curcuma amada.*

A detailed study of the *Alternaria* blight of *Cyamopsis tetragonoloba* Taub (Cluster beans), has been made by Rangaswami and Rao.[127] The authors after comparing the morphological, cultural and pathogenicity characters of the isolate with known strains of *Alternaria*, propose the name *Alternaria cyamopsidis* Rangaswami and Venkata Rao sp. nov., to this pathogen. A *Phytophthora* blight specific to *Sesamum orientale* (Sesamum) has been described by Kale and Prasad.[128] In Gujrat the incidence of the disease was found to be as high as 66 per cent. The isolated fungus is related to *Phytophthora parasitica* Dast. On account of its highly specialised parasitic nature the authors assign to it the new name *Phytophthora parasitica* var. *sesami.*

Chowdhury [129] has reported his observations on the ripe fruit rot of chillies, a disease widespread in Assam where 12 to 32 per cent of the fruits are destroyed by the fungus. The optimal temperature, pH and humidity conditions for the growth of the fungus and the spread of this air-borne disease have been studied and the action of some common antifungal agents has been described. The fruit rot of *Solanum melongena* L (Brinjal) caused by *Phomopsis vexans* (Sacc and Syd.) has been described by Pawar and Patel.[130] This disease is specific to brinjal plants as the fungus does not attack any other host plants. Diseases of *Acacia catechu* due to *Fomes badius* which causes heart rot and *Ganoderma lucidum* and *Polyporus gilous* which cause root rot are described by Bakshi.[131] A correlation between soil structure and root rot diseases in *Shisham* has been attempted by Bakshi *et al.*[132] Working with the same species of plants, Bakshi [133] has dealt with the biological characterisation of *Fusarium solani* responsible for the wilt disease in *Shisham.* While dealing with the heart rot in relation to the management of *Shorea robusta* (Sal), Bakshi [134] has described *Fomes caryophylli*, *Fomes fastuosus* and *Hymenochaete rubiginosa* as responsible for the decay of the trees, thereby causing serious economic loss. Sinha [135] has described *Polyporus shorea* responsible for the root rot as one of the factors leading to the decay of *Shorea robusta.* *Polystictus sanguineus*, one of the widely distributed Polypores encountered normally as a saprophyte has been described as a parasite on *Shorea robusta* by Banerjee [136] who has confirmed its parasitic nature by inoculation experiments. Occurrence of *Physoderma* species on *Marsilea minuta* L. has been reported by Narayanaswami and Rangaswami.[137]

A brief account of the morphology and pathogenecity of *Piricularia oryzae* Cav. f. brachiariae, occurring in India on *Brachiaria mutica* Stapf., a gramineae has been described as a new record by Rao and Rao.[138] Rangaswami and Subramanian [139] have published their observations of the loss due to *Piricularia oryzae* Cav. infection of paddy in terms of loss of grain and straw yield. Chattopadhyay and Chakrabarti [140] have recorded the relationship between anatomical characters of the leaf and resistance to infection of *Helminthosporia oryzae* in 5 different varieties of paddy. Padmanathan [141] studying the relationship between the loss in viability of rice and seed-borne microflora, has concluded that the mould activity has no direct relationship to the inactivation of the embryo in the rice seeds stored under wet and humid conditions.

Ghosh [142] has described the cultural and morphological characters of species of *Colletotrichum* responsible for the anthracnose disease of jute plants in Bengal. Comparative studies carried out with Malayan and Japanese strains of anthracnose disease fungi showed that the Bengal variety is closely allied to the latter. Bhide *et al.*[143] have summarised the methods for the control of seed borne infection of cotton in Bombay State. Agnihothrudu and Barua [144] have described the cultural and morphological characteristics of an interesting tuberculariaceous fungus isolated from the stems of *Albizzia richardiana*. The fungus is named *Kutilakesopsis malcalpineae*, Agnihothrudu and Barua sp. nov. and included in the new genus *Kutilakesopsis*.

Grewal [145] has noted the effect of 19 carbon compounds on the growth and sporulation of *Gloeosporium papayae*, *Gloeosporium musarum* and *Colletotrichum papayae*. Sarkar [146] has published an interesting review on the isolation of gibberellic acid from *Fusarium moniliformi* and its action on the growth of plants *via a vis* its economic uses. Rao [147] has described a chromatographic method for the qualitative and quantitative determination of gibberellic acid in *Fusarium moniliformi* infected rice plants. Agnihothrudu and Barua [148] have reported the occurrence of a rare fungus *Cephaliospora tropica* from the rhizosphere of tea plants. Bakshi [149] has studied the mycorrhiza occurring in some of the Indian conifers. Thind and his collaborators [150-153] have published a comprehensive survey of the *Peziziaceae* of the Mussorie Hills. The authors [154, 155] further describe the ecological distribution of the *Myxomycetes* and the *Clavariaceae* for the same region. Subramanian,[156, 157] Subramanian and Ramakrishnan,[158] Ramakrishnan,[159, 160] Salam and Rao [161] and Chona *et al.*[162] have contributed to our knowledge of Indian fungi.

Rao *et al.*[163] have studied the influence of the comm on sulpha drugs under pot culture conditions on sugarcane. The influence on the variation of growth of sugarcane has been expressed on the basis of the mechanism of action of these drugs. Rangaswami [164, 165] has reported the effect of some antibiotics like streptomycin, mycothricin, mycostatin, etc. on *Xanthomonas malvacearum* and on the microflora of cotton seed. The author has presented the relative *in vitro* antifungal and antibacterial values of these antibiotics. The morphological and cultural differences exhibited by the streptomycin resistant and non-resistant strains of *Xanthomonas citri* and *Xanthomonas malvacearum* have been further described. Rao and Subbiah,[166] subsequent to field trials, have reported their findings on the efficacy of several fungicides in the control of *Pythium aphanidermatum* in chilli and tobacco plants. While most of the fungicides were highly active, it is reported that none were found phytotoxic to the seedlings of these two plants. Rangaswami and Damodaran [167] have tested mycostatin for its action on *Helminthosporium torulosum* (Syd.) Ashby, *Gloeosporium musarum* Cke. and Masse, and *Fusarium orthoceras* var. *cubense* (E. S. Sm) Snyder and Hansen, pathogenic to banana. Bhargava and Gupta[168] have described the cottony leak of beans caused by *Pythium debaryanum*. The disease is known to spread rapidly at 20° to 25°C under conditions of storage. Careful handling and other sanitary measures are considered of value in the elimination of the disease.

MacMillan *et al*,[169, 170] while evaluating some of the proofing agents against microbial and actinomycal damage of jute materials observe that samples proofed with copper compounds produce the best rot resistance. Of these copper naphthanate and cuperron as well as 8-hydroxy quinoline copper compounds gave the best results. Working further on the evaluation of the proofing agents against weathering they observed that microbial rot induced mainly by exposure to sunlight (weathering) is partly reduced by cutch and chromium while copper treatment was found inadequate.

Pant *et al.*[171] have produced amylases from Indian soil actinomycetes employing media composed of cheap indigenous ingredients. Their activities are comparable to those of commercial diastases. With an object to conserve monsoon fodders by ensilage, Kehar and Murthy [172] have carried out experiments by combining the leguminous plant *Cassia tora* with paddy straw. Feeding experiments in cattle and buffaloes and metabolic trials have shown its value as a maintenance ration for cattle and buffaloes.

Roy and Mukerjee [173] claim to have isolated a new type of nitrogen fixing bacterium. Both morphologically and physiologically the organism was found to differ from the known nitrogen fixing bacteria. This pleomorphic organism which occurs singly, in pairs and in triplets is Gram negative in character, aerobic to microaerophilic in its oxygen requirements and grows best at an optimum temparature of 28°C. The organism utilises among other carbohydrates, especially glucose and mannitol. Practically no growth is obtained with inorganic nitrogen compounds. Anand and Puri [174] have reported their observations relating to problems concerning biological fixation of nitrogen in some Indian soils.

REFERENCES

1 Thyagarajan, T. R. and Subramaniam, M. K. (1957), Proc. Indian Acad. Sci., **45B**, 187.

2 Sharma, T. R. and Shukla, J. P. (1957), J. Sci. & Ind. Res. **16C**, 214.

3 Chiddarwar, P. P. (1957), Sci. & Cult., **22**, 511.

4 Bose, S. K. (1957) Indian J. Med. Res., **45**, 249.

5 Banerjee, A. K., Mukherjea, A. K., Ray, H. N., Rao, A. and Chakraborty, A. N. (1957), Bull. Calcutta School, Trop. Med. **5**, 177.

6 Mukherjea, A. K., Ray, H. N. and Chakraborthy, B. M. (1957), *Ibid.*, **5**, 64.

7 Mukherjea, A. K. and Ray, H. N. (1957), *Ibid.*, **5**, 176.

8 Bose, S. R. (1957), Nature, **180**, 45.

9 Ram, C. S. V. (1957), Experientia, **13**, 284.

10 Lakshmanan, M. and Ram, C. S. V. (1957), Proc. Indian Aca. Sci., **45B**, 131.

11 Lakshminarayanan, K. and Subramanian, D. (1957), Experientia, **13**, 350.

12 Dasgupta, A. and Nandi, P. N. (1957), Nature, **179**, 429.

13 Gondhalekar, R. S. and Phadke, R. S. (1957), J. Sci. Indust. Res. **16C**, 188.

14 Mitra, K. K. (1957), Experientia, **13**, 356.

15 Khambata, S. R. and Bhat, J. V. (1957), Arch. mikrobiol., **28**, 69.

16 Ramakrishnan, T., Indira, M. and Sirsi, M. (1957), Nature, **179**, 1356.

17 Ganguli, S. (1957), Indian J. Med. Res., **45**, 173.

18 Shukla, J. P. and Prabhu, K. A. (1957), Proc. annu. Conv. Sug. Technol. Ass., **25**, 155.

19 Sreenivasan, A. (1957), Curr. Sci., **26**, 392.

20 Majumdar, S. K. and Padma, M. C. (1957). Canad. J. Microbiol., **3**, 639.

21 Iyengar, M. R. S. and Ganju, P. L. (1957), Indian Phytopath, **10**, 142.

22 Visvanathan, L. and Sarma, P. S. (1957), Nature, **180**, 1370.

23 Bhaskaran, K. (1957), Nature, **180**, 43.

24 Bhagawan, N. V., Nimbkar, Y. S. and Rao, S. S. (1957), Indian J. Med. Res., **45**, 1.

25 Guha, A. (1957), Nature, **180**, 1360.

26 Bose, A. K (1957), Sci. & Cult., **23**, 23.

27 Murti, B. R. and Shrivastava, J. B. (1957), Indian J. Med. Sci., **11**, 580.

28 Banerjee, G. and Roy, D. K. (1957), Sci. & Cult., **23**, 153.

29 Ghosh, S. R. and Dutta, S. K. (1957), Indian J. Pharm., **19**, 96.

30 Alimchandani, H. R. and Sreenivasan, A. (1957) Proc. Indian Acad. Sc., **45B**, 21.

31 *Idem*. (1957) *Ibid*., **45B**, 27.

32 Ranganathan, B. and Sastry, C. A. (1957), J. Indian Inst. Sci., **39A**, 259.

33 Balakrishnan, S., Baliga, B. R. and Rajagopalan, R. (1957), Indian J. Med. Res., **45**, 55.

34 Subrahmanyan, V., Krishnamurthy, K., Sreenivasamurthy, V. and Swaminathan, M. (1957) J. Sci. Ind. Res., **16C**, 173.

35 Bhagwan, H. N. and Rajagopalan, R. (1957), J. Sci. & Ind. Res., **16C**, 115.

36 Lulla, B. S. and Johar, D. S. (1957), J. Sci. & Ind. Res., **16C**, 45.

37 Sastry, K. S. and Sarma, P. S. (1957), Nature, **179**, 44.

38 Alimchandani, H. R. and Sreenivasan, A. (1957), J. Bact., **73**, 538.

39 *Idem*. (1957) *Ibid*., **74**, 171.

40 *Idem*. (1957) *Ibid*., **74**, 175.

41 Datta, J., Battacharya, K. R. and Roy, D. K. (1957), Ann. Biochem. Exptt. Med., **17**, 35.

42 Grewal, J. S. (1957), Indian Phytopath, **10**, 121.

43 Krishnan, P. S., Damle, S. P. and Bajaji, V. (1957), Arch. Biochem. Biophys. **67**, 35.

44 Roy, D. K. (1957). Ann. Biochem. Expt. Med. **17**, 127.

45 Sankhala, R. H. (1957), J. Sci. & Ind. **19C**, 119.

46 Ramakrishnan, C. V. (1957). Naturwissenschaften, **44**, 401.

47 Singh, J. and Singh, G. (1957). J. Sci. & Ind. Res., **16C**, 219.

48 Singh, J. and Dutt, I (1957) *Ibid.*, **16C**, 164.

49 Singh, J. (1957), *Ibid.*, **16C**, 113.

50 Pal, P. R., Banerjee, B. N. and Guha, B. C. (1957), Ann. Biochem. Expt. Med., **17**, 151.

51 Gonsalves, A., Nambudripad, V. K. N., Lakshminarayana H. and Iya, K. K. (1957), Indian J. Dairy Sci., **10**, 25.

52 Nambudripad, V. K. N., Gonsalves, A., Laxminarayana, H. and Iya, K. K. (1957), *Ibid.*, **10**, 157.

53 Anand, J. C. and Johar, D. S. (1957). J. Sci. & Ind. Res., **16A**, 370.

54 Shrikantan, T. N., Agarwala, S. C. and Shrivastava, D. L. (1957), Indian J. Med. Res., **45**, 151.

55 Saxena K. C., Sagar, P., Agarwala, S. C. and Shrivastava, D. L. (1957), *Ibid.*, **45**, 161.

56 Popli, S. P. and Mukerji, B. (1957), J. Sci. & Ind. Res., **16A**, 440.

57 Kaushiva, B. S. (1957), *Ibid.*, **16C**, 210.

58 Ray, S., Mukherjea, A. K. and Ray, H. N. (1957), Bull. Cal. School Trop. Med., **5**, 178.

59 Gopalchari, R. (1957), J. Sci. & Ind. Res., **16C**, 143,

60 Iyer, R. N., Nitya Anand and Dhar, M. L. (1957), *Ibid.*, **16C**, 157.

61 Kaushiva, B, S. (1957), *Ibid.*, **16C**, 224.

62 Bhattacharya, A. and Basu, S. P. (1957), Bull. Cal. School Troop. Med., **5**, 53.

63 Basu Roy, B. and Nandy, K. (1957), J. Indian Med. Ass., **29**, 191.

64 Krishnaswami, K. V. and Vaidyanathan, N. (1957). *Ibid.*, **29**, 187.

65 Sarin, L. R. and Das Gupta, A. (1957). *Ibid.*, **29**, 186.

66 Chopra, I. C., Khajaria, B. N. and Chopra, C. L. (1957), Antibio. and Chemo, **7**, 4.

67 Patel, R. P. and Patel, K. C. (1957), Indian J. Pharm., **19**, 70.

68 Patel, R. P. and Trivedi, B. M. (1957), *Ibid*,, **19**, 228.

69 *Idem.* (1957), Indian J. Med. Sci., **11**, 881.

70 Satwalekar, S. S., Gupta, T. R. and Rao, P. L. N. (1957), J. Indian Inst. Sci., **39A**, 195.

71 Subrahmanyam, V., Krishnamurthy, K., Sreenivasamurthy, V. and Swaminatham, M. (1957), J. Sci. Ind. Res., **16C**, 240.

72 Chakraborty, D. P., Das Gupta, A. and Bose, P. K. (1957), Ann. Biochem. Expt. Med., **17**, 59.

73 Das, B. R., Kurup, P. A. and Rao, P. L. N. (1957), Ind. Jour. Med. Res., **45**, 191.

74 Subrahmanyan, V., Lulla, B. S., Rao, M. N., Johar, D. S. and Swaminathan, M. (1957), Ann. Biochem, Expt. Med., **17**, 155.

75 Ganapathi, K. (1957), Experientia, **13**, 172.

76 Deshpande, V. N. and Ganapathi, K. (1957), *Ibid.*, **13**, 475.

77 Ghosh, H. and Guha Thakurta, A. K. (1957), Sci. & Cult., **22**, 570.

78 Dhala S. A. and Bhantnagar, S. S. (1957), J. Sci. & Ind. Res., **16C**, 30.

79 Dhala, S. A., Poonawalla, F. M. and Bhatnagar, S. S. (1957), *Ibid.*, **16C**, 76.

80 Vora, V. C., Shete, K. and Dhar, M. M. (1957), **16C**, 182.

81 Tirunarayanan, M. O. and Sirsi, M. (1957), J. Indian Inst. Sci., **39A**, 185.

82 *Idem.* (1957), *Ibid*,, **39**, 215.

83 Rangam, M. C. and Manjrekar, P. S. (1957), Indian J. Med. Sci., **11**, 896.

84 Rangam, M. C., Bhagwat, R. R. and Lokre, R. J. *Ibid.*, **11**, 11.

85 Shah, N. M., Kamat, S. R. and Vaidya, M. D. (1957), *Ibid.*, **11**, 221.

86 Gupta, S. K. and Mathur, I. S. (1957), J. Sci. & Ind. Res., **16C**, 192.

87 Pohowalla, S. N., Arora, M. M. and Singh, B. N. (1957), Indian J. Med. Sci., **11**, 15.

88 Banerjee, S. and Ghosh, H. (1957), Proc. Soc. exp. Biol. and Med., **94**, 668.

89 Banerjea. A., Chatterji, D. N. and Pramanick, K. (1957), Ann. Biochem. Expt. Med., **17**, 99.

90 Mukerjee, S., Guha, D. K. and Guha Roy, U. K. (1957), *Ibid.*, **17**, 161.

91 Guha, D. K., Rudra, B. C. and Mukerjee, S. (1957), *Ibid.*, **17**, 203.

92 Banerjee, S., Bhaduri, J. N. and Sarkar, A. K. (1957), Indian J. Med. Res. **45**, 9.

93 Banerjee, G. and Roy, D. K. (1957), Sci. & Cult., **23**, 203.

94 Sarin, J. C., Andleigh, H. S. and Metha, J. B. (1957), Indian J. Med. Sci., **11**, 708.

95 Roy, A. N. and Banerjee, G. (1957), Ann. Biochem. Expt. Med., **17**, 11.

96 Chatterjee, K. R., Ray, H. N. and Mukerjee. N. (1957), Indian J., Med. Sci., **11**, 714.

97 Babbar, O. P. and Dhar, M. M. (1957), J. Sci. & Ind. Res., **16C**, 166.

98 Bhatt, P. N. and Work, T. H. (1957). Proc. Soc. Expt. Biol. Med., **96**, 213.

99 Soman. D. W. and Nimbkar, Y. S. (1957), Jour. J. J. Group of Hospitals & G. M. C., **2**, 277.

100 Banerjee, S. and Chaterjee, S. P. (1957), Proc. Soc. exp. Biol., and Med., **94**, 474.

101 Banerjea, A. (1957), Ann. Biochem, Expt. Med., **17**, 67.

102 *Idem.* (1957), *Ibid.*, **17**, 197.

103 Saha, K., Bromwich. D. W. and Chaudhuri, S. N. (1957), *Ibid.*, **17**. 187,

104 Chatterjee, B. R., Saha, K. and Chaudhuri, S. N. (1957), *Ibid.*, **17**, 193.

105 Darekar, M. R. and Jhala, H. I. (1957), Bri. J. Vener. Dis. **33**, 120.

106 Banker, D. D. (1957), Ind. J, Med. Sci. **11**, 345.

107 *Idem.* (1957), *Ibid.*, **11**, 430.

108 *Idem.* (1957), *Ibid.*, **11**, 516.

109 *Idem.* (1957), *Ibid.*, **11**, 657.

110 *Idem.* (1957), *Ibid.*, **11**, 767.

111 *Idem.* (1957), *Ibid.*, **11**, 847.

112 *Idem.* (1957), *Ibid.*, **11**, 949.

113 Mukherji, A. (1957), J. Sci. & Ind. Res. **16C**, 1.

114 Kalra, L. and Dumbrey, D. G. (1957), Armed forces med. J. India, **13**, 3.

115 Chatterjee, A. N. and Ghosh, J. J. (1957), Nature, **180**, 1425.

116 Sukapure, R. S., Bhide, V. P. and Patel, M. K. (1957), Indian Phytopath., **10**, 11.

117 Chattopadhyay, S. B. and Basu, P. K. (1957), Sci. & Cult., **23**, 320.

118 Bedi, K. S. (1957), Indian Phytopath, **10**, 133.

119 *Idem.* (1957), *Ibid.*, **10**, 138.

120 Vasudeva, R. S., Lele, V. C. and Misra, D. P. (1957), *Ibid.*, **10**, 157.

121 Vasudeva, R. S., Lele, V. C. and Rao, M. H. (1957), *Ibid.*, **10**, 158.

122 Sundaram, N. V. and Rao, A. V, (1957), Sci. & Cult., **23**, 98.

123 Sharma, S. L. (1957), Pro. Indian Acad. Sci., **46B**, 126.

124 Chandra, V. (1957), Sci. & Cult., **23**, 99.

125 Pawar, V. H. and Patel, M. K. (1957), Indian Phytopath, **10**, 110.

126 Ramkrishnan, K. and Sundaram, N. V. (1957), Proc. Indian Acad. Sci., **45B**, 149.

127 Rangaswami, G. and Rao, A. V. (1957), Indian Phytopath, **10**, 18.

128 Kale, G. B. and Prasad, N. (1957), *Ibid.*, **10**, 38.

129 Chowdhury, S. (1957) *Ibid.*, **10**, 55.

130 Pawar, V. H. and Patel, M. K. (1957), *Ibid.*, **10**, 115.

131 Bakshi, R. K. (1957), Indian Forester, **83**, 555.

132 Bakshi, R. K., Arora, K. K. and Singh, S. (1957), *Ibid.*, **83**, 555.

133 Bakshi, R. K. (1957), *Ibid.*, **83**, 505.

134 *Idem.* (1957), *Ibid.*, **83**, 651.

135 Sinha, R. L. (1957), *Ibid.*, **83**, 47.

136 Banerjee, S. (1957), Sci. & Cult., **23**, 100.

137 Narayanaswami, S. and Rangaswamy, N, S. (1957), J. Indian Bot. Soc., **36**, 104.

138 Rao P. G. and Rao, D. K. (1957), Indian Phytopath, **10**, 107.

139 Rangaswami, G. and Subramanian, T. V. (1957), Sci. & Cult., **23**, 172.

140 Chattopadhyay, S. B. and Chakrabarti, N. K. (1957), Indian Phytopath, **10**, 130.

141 Padmanathan, S. Y. (1957), Pro. Indian Acad. Sci., **46B**, 155.

142 Ghosh, T. (1957), Indian Phytopath., **10**, 63.

143 Bhide, V. P., Desai, M. K. and Rane, M. S. (1957), Indian Cot. Gr. Rev. **11**, 496.

144 Agnihothrudu, V. and Barua G. C. S. (1957), J. Indian Bot. Soc., **36**, 306.

145 Grewal, J. S, (1957), Indian Phytopath., **10**, 121.

146 Sarcar, S. (1957), Sci. & Cult., **23**, 233,

147 Rao, N. S. S. (1957), Proc. Indian Acad. Sci., **45B**, 91.

148 Agnihothrudu, V. and Barua, G. S. C. (1957), Sci. & Cult., **22**, 569.

149 Bakshi, B. K. (1957), Mycologia, **49**, 269.

150 Thind, K. S. and Batra, L. R. (1957), J. Indian Bot. Soc., **36**, 51.

151 Thind, K. S. and Sethi, T. S. (1957), *Ibid.*, **36**, 196.

152 Thind, K. S. and Sethi, T. S. (1956), Indian Phytopath., **10**, 27.

153 Thind, K. S. and Batra, L. R. (1957), J. Indian Bot. Soc., **36**, 428.

154 Thind, K. S. and Rehill P. S. (1957), Indian Phytopath., **10**, 86.

155 Thind, K. S. and Sukh Dev. (1957), J. Indian Bot. Soc., **36**, 92.

156 Subramanian, C. V. (1957), *Ibid.*, **36**, 61.

157 *Idem.* (1957), Proc. Indian Acad. Sci., **45B**, 282.

158 Subramanian, C. V. and Ramakrishnan, K. (1957), J. Indian Bot. Soc,, **36**, 68.

159 Ramakrishnan, T. S. (1957), Proc. Indian Acad. Sci., **45B**, 176.

160 *Idem.* (1957), *Ibid.*, **46B**, 149.

161 Salam, M. A, and Rao, P. N. (1957), J. Indian Bot. Soc., **36**, 421.

162 Chona, B. L., Munjal, R. L. and Kapoor J. N. (1957), Indian Phytopath., **10**, 148.

163 Rao, M. S. S., Prasad, R. B. and Khanna, M. L. (1957), Proc. Indian Acad. Sci., **45B**, 225.

164 Rangaswami, G. (1957), Indian Phytopath., **10**, 8.

165 *Idem.* (1957), Curr. Sci. **26**, 185.

166 Rao, P. G. and Subbaiah, J. (1957), Indian Phytopath., **10**, 50.

167 Rangaswami, G. and Damodaran, A. P. S. (1957), *Ibid.*, 10, 126.

168 Bhargava, K. S. and Gupta, S, C. (1957), *Ibid.*, **10**, 49,

169 MacMillan, W. G., Basu, S. N. and Pal, P. N. (1957), J. Sci. & Industr. Res., **16C**, 13.

170 *Idem.* (1957), *Ibid.*, **16C**, 95.

171 Pant, K. D., Sethe, K. and Krishnamurthi, C. R. (1957), *Ibid.*, **16C**, 101.

172 Kehar, N. D. and Murthy, V. N. (1957), *Ibid.*, **16A**, 374.

173 Roy, A. B. and Mukherjee, M. K. (1957), Nature, **180**, 236.

174 Anand, V. D. and Puri, B. R. (1957), J. Indian Soc. Soil Sci., **5**, 163.

PHARMACOLOGY

M. L. GUJRAL AND B. N. DHAWAN
Department of Pharmacology
K. G. Medical College, Lucknow

The number of papers published by workers in this country on pharmacodynamics and allied subjects after the publication of the last review in 1954 runs into several hundred. It has not been possible, therefore, to include all of these in the present review. Only a selected number of papers has been considered and it is possible that due to inadequate library facilities even some important papers may have escaped notice. For this, the present reviewers crave the indulgence of both the authors whose work has not been included and the readers. The papers have been classified under a number of headings and subjects on which only a few papers were available have been discussed under the heading of miscellaneous papers.

Nervous System

Hypnotics : A new class of potent hypnotics, 2, 3-disubstituted quinazolones was introduced by Gujral and his co-workers. Out of twenty-two drugs screened nine were found to possess significant hypnotic activity [1] and seven of them were studied in detail to assess their hypnotic potency, toxicity and safety margin.[2] 2-methyl-3-orthotolyl-4-quinazolone (QZ-2) was found to be more active and safer than phenobarbitone while 2-methyl-5-phenyl-4-quinazolone (QZ-1) was safer but weaker than phenobarbitone. Two of these compounds QZ-2 and QZ-4 (2-ethyl-3-phenyl-4-quinazolone), were clinically studied on medical and surgical patients and healthy volunteers and both were found to possess a significant hypnotic activity without producing any effect on blood pressure, pulse or respiration.[3]

Anticonvulsants : Gujral *et al.*[4] studied the anticonvulsant effect of three quinazolones, QZ-1, QZ-2 and QZ-4 quantitatively. QZ-2 was the most potent of the three but was weaker than diphenylhydantoin in maximal electroshock seizures. Against metrazol induced seizures, however, it was more potent than phenobarbitone. Gujral and Dhawan[5] investigated the effect of five antiepileptic drugs on the anticonvulsant activity of mysoline. Diphenylhydantoin-mysoline combinations gave best results in electroshock test, and in metrazol test optimum potentiation was obtained with tridione and mysoline. Mukherjee and Chakravarty[6] showed that sodium bromide also depressed carbonic anhydrase activity of brain. Chakravarty *et al.*[7] have correlated the anticonvulsant effect of bromides with intracellular electrolyte and acid base changes, and have explained the action of bromides by the efflux of brain cell sodium secondary to an inhibition of brain carbonic anhydrase. Mondkar *el al.*[8] reported clinical trials in petit mal cases with a new drug malidone.

Chlorpromazine : Gujral *et al.*[9] showed that chlorpromazine was the most potent protective agent against emetine and digitalis induced emesis in pigeons. Ahmad[10] found that it protected dogs against apomorphine induced vomiting. Its potentiating effect on hypnotics, analgesics and anticonvulsants was reported by Gujral *et al.*[11-15] and Ahmad and Goswami.[16] Das Gupta and Hausler[17] found that it failed to inhibit hypothalmic antidiuretic effect of nicotine in rats. Malhotra and Mehta[18] compared the effect of some central depressants in antagonising the central nicotinic activity in rabbits. Chlorpromazine was least effective while reserpine was markedly effective. Das Gupta[19] studied its effect on lymphocytopenia of stress in rabbits and diencephalic cats. It was found to depress alkaline phosphatase activity of both cytoplasm and nucleus of brain cells, particularly of areas known to be rich in R. N. A.[20] without affecting the brain acetylcholine esterase.[21] Rajgopalan[22] used it for preanaesthetic medication and found it to be an ideal drug for that purpose.

Lahiri[23] investigated some cardiovascular effects of chlorpromazine. Its hypotensive effect was more marked in hypertensive than in normotensive rats and tolerance appeared in 3-4 weeks. Potentiation of hypotensive effect was observed with high doses of reserpine and low doses of hexamethonium. No toxic effects were seen in electrocardiogram. Arora and Madan[24] found it stronger than quinidine in bringing about reversion of auricular flutter in dogs. Das Gupta and Hausler[25] studied effects of chlorpromazine on respiration and concluded that changes in respiration were reflex and occurred simultaneously with fall of blood pressure. Das Gupta[26] reported that it supressed oestrus cycle in rats probably by a central effect. However, it failed to prevent induced continuous estrus in normal[26] or ovariectomised rats.[27]

Analgesics and Antipyretics : Gujral and Khanna[28] compared the analgesic activity of five narcotic analgesics in albino rats, and dilaudid was found to be the most potent. Saxena and his co-workers studied the effect of several autonomic drugs on morphine analgesia in rats. The effect was potentiated by neostigmine bromide,[29] ephedrine sulphate and amphetamine hydrochloride.[30] The latter two drugs also potentiated analgesia by phenylbutazone. Atropine sulphate and hyoscine hydrobromide failed to reduce the analgesic effect of morphine.[31] Shah and Sheth[32] reported the effect of neostigmine on intensity and duration of pethidine analgesia in rats.

Gujral *et al.*[33,34] screened 56 indigenous drugs for antipyretic activity in rats made pyretic by yeast injection. Two of them, *Wrightia tinctoria* and *Woodfordia floribunda*, showed an activity better than acetylsalicylic acid. Saxena and Khanna[35] found that QZ-1 and QZ-2 (*vide supra*) possessed hypothermic and antipyretic effects in rats which were not related to their hypnotic effect and resembled the effects of chlorpromazine on body temperature.

Local Anaesthetics : Arora and Sharma[36-38] reported on the pharmacology of four new local anaesthetics, 4-n-Butoxy β (1-piperidyle) Propiophenone HCl, β-diethylaminoethyl pn-hexyloxy benzilate HCl, Pyrollocaine and Di (β-o-Methoxyphenyl isopropyl) amine lactate. The last one was forty times more potent surface anaesthetic than cocaine and eighty times more potent than procaine as an infiltration anaesthetic. In addition it was also a potent bronchodilator.

Sinha[39] reported that low concentration of sodium ion in Ringer's solution increased anti-acetylcholine effect of procaine and cocaine on frog rectus, while high concentration had an opposite effect. Similar results were obtained on rabbit and guinea-pig ileum and cat trachea using Tyrode solution. Sinha[40] found that many local anaesthetics have a stimulant action on isolated uteri of different animals which is not antagonised by atropine, mepyramine, F-933 or hexamethonium. The effect is unrelated to local anaesthetic potency. Bhattacharya and Atanackovic[41] showed that procaine was not an effective bronchodilator. It could, however, block the bronchospastic effects of histamine and acetylcholine but not those of 5-HT.

Neuromuscular Junction : Ray *et al.*[42] screened 20 polymethylene bis-onium ether compounds for neuromuscular blocking properties. Bis-piperidinum dibutyl ether butiodide was found to be most potent. Rastogi *et al.*[43] found that bis-onium compounds carrying p-nitrobenzyl radicals showed strong curariform activity. Lahiri and Sen[44] observed that muscle relaxants produce a fall of blood creatinine level which is not helped by blood transfusion. Sinha and Rajapurkar[45] investigated the influence of ferrous ion on neuromuscular junction. It was found to produce a neuromuscular block similar to that of curare.

Arora[46] and Arora and Dandiya[47,48] studied the SAR of antiveratrinic effect of cinchona alkaloids and chloroquine and related drugs on frogs' skeletal muscle. They concluded that the cardiac action of these drugs is based on the same stereo-chemical and chemical requirement as the antiveratrinic action but the two are not directly proportional to antimalarial activity. Quinoline ring was shown to be responsible for the antiveratrinic activity of these compounds and this was increased by chlorine substitution on the ring. Optical rotation had no effect. Arora and Das[49] studied antiveratrinic and antiarrhythmic properties of thirty-three compounds. They found that all antiarrhythmic compounds had antiveratrinic action but the two actions were not dependent on any definite chemical configuration.

Miscellaneous : Subbu and Subrahmanyam[50] found that nikethamide produced peripheral vaso-dilatation and metrazol had no effect on peripheral vascular system and questioned the validity of their use in shock and collapse. Pradhan *et al.*[51] reported that the duration of urethane anaesthesia was greatly prolonged by concurrent administration of epinephrine in mice. Roy and Kuperman [52] found that nicotoninhydroxyamine acid methiodide (NHMI) could reverse the effects of TEPP on rabbit's isolated auricle and gut without blocking the effects of choline esters. They believe that NHMI acts by reactivating cholinesterase. Ahmad and Taylor [53] described a method for assay of acetylcholine on superfused frog rectus muscle with proved 10-20 times more sensitive than bath preparations. Bose and Gupta [54] investigated the effect of antimalarials on acetylcholine content of rat heart, brain and liver. Paludrine, quinine and mepacrine caused a decrease in acetylcholine synthesis. Agarwal and Harvey [55] showed that long duration of action of dibenzyline was due to a firm chemical combination of the drug with a cellular receptor substance and not due to its storage in body fat.

Rauwolfia Alkaloids and Related Drugs

Indian workers continued to take immense interest in working out the complicated pharmacodynamic effects of Rauwolfia alkaloids. A large number of papers has been published on Rauwolfia alkaloids during the period under review but only the important ones are summarised here.

Bhargava and Borison [56-59] in a series of papers throw light on the locus of hypotensive activity of various Rauwolfia alkaloids including reserpine. They studied the differential effects of Rauwolfia alkaloids on hypothalmic, medullary and spinal vasomotor activity with the help of stereotaxic technique for electrical stimulation of vasomotor centers. Alseroxylon was found to have a depressant action on spinal, medullary and hypothalmic level. Reserpine had no spinal component and only a moderate depressant effect on supraspinal mechanisms. Hypotension could be demonstrated even following midcollicular decerebration thus excluding the hypothalmic site, commonly believed to be the chief site of action. They further showed that the alkaloids rescinnamine and reserpinine resemble reserpine while serpentine and ajmaline acted like alseroxylon. Ajmalicine was shown to possess also a central depressant activity by cross circulation technic, in addition to a peripheral action. They conclude that reserpine does not significantly contribute to pronounced hypotensive activity of alseroxylon.

A number of papers appeared concerning the actions of rauwolscine hydrochloride. Das *et al.*[60] showed that in cat and rhesus monkey it caused a marked fall in total peripheral resistance without significantly altering cardiac output. Kohli *et al.*[61] compared adrenergic blocking activity of rauwolscine with yohimbine and tolazoline by a number of methods. They showed that the nature and intensity of adrenergic block by rauwolscine was similar to yohimbine and 2.5-3 times more than tolazoline. Razdon and Das[62] studied the effect of rauwolscine on E. E. G. In low doses it has a stimulating effect but in higher doses the fundamental action is hypnotic. Mukherjee and Werner[63] showed that it caused statistically significant depletion of ascorbic acid from rats' adrenal glands. Chatterjee and Talapatra[64] prepared reserpine analogue of rauwolscine. It showed hypotensive activity comparable to reserpine but the sedative properties were not so marked.

Kothari *et al.*[65] studied the action of reserpine free extract of Rauwolfia serpentina (R. S.) on adrenal cortex and found that it prevents stress induced activation of adrenal cortex.

Arora and Madan[66; 67] investigated antiarrhythmic effect of some Rauwolfia alkaloids. They found that ajmaline and serpentine are more active than quinidine in certain tests on rabbit's and dog's atria. Arora[68] also reported on antiveratrinic action of Rauwolfia alkaloids. Reserpine is the most potent alkaloid in this respect while rescinnamine is devoid of any antiveratrinic action on frog's sartorius. Chatterjee[69] observed that in small concentration R.S. has a competitive antagonism with acetylcholine on skeletal muscle and in high concentrations it increases the tone and contraction.

Chatterjee and his co-workers investigated the autonomic and antihistaminic effects of R.S. alkaloids.[70-75] Antiacetylcholine and antihistaminic effect has been studied on rabbit's isolated gut. Ajmaline, however, exerts a direct spasmogenic effect also in addition. They also show antiadrenaline effect on cat's blood pressure, perfused isolated heart of toad and isolated rabbit's auricles. In addition they antagonise the nicotinic effect of acetylcholine and nicotine on blood pressure of atropinised cat. Bannerjee and Lewis [76] and Bannerjee [77] also report on the anticholinergic action of alseroxylon on skeletal, smooth and cardiac muscles.

Chatterjee *et al.*[78] observed a rise in blood sugar with reserpine and a fall in blood sugar with total alkaloids of R. S. The results have been both supported [79] and contradicted [80] by foreign workers.

Sirsi and his co-workers [81–84] also reported on certain aspects of pharmacology of R.S. including the antibacterial effect and effect on biliary secretion and endocrines. Rindani and Antia [85] found that reserpine free extract of R.S. had no effect on basal gastric acidity but prevented insulin induced acidity. Kohli [86] failed to find any growth promoting effect of reserpine or total alkaloids of R.S. on young albino rats. Increase in coagulation and prothrombin time of blood was seen by Khirwadkar [87] in two cases. Bhattacharya and Lewis [88] showed that reserpine specifically depletes 5-HT from mast cells without disrupting them. A selective depression of chemoreceptor trigger zone for vomiting by reserpine and alseroxylon is suggested by the findings of Malhotra and Siddhu [89] that while antagonising apomorphine, morphine and ergot, they are ineffective against veratrum or copper sulphate induced vomiting. Chauhan [90] showed an anticonvulsant effect of reserpine in rabbits. Bose and Vijaywargiya [91] studied the effect of Rauwolfia alkaloids and serpentine on respiration of brain and cardiac tissue. Reserpine and serpentine are potent inhibitors of respiration of both these tissues while ajmaline has a stimulant action. The action is probably exerted on respiratory dehydrogenases and may be responsible for various pharmacodynamic effects of these alkaloids. Ghosh and Basu [92] isolated a sterol (Serposterol) from oleoresin fraction of R. S. which has given encouraging results in mental cases. Dhar *et al.*[93] identified two metabolites of reserpine, reserpic acid and reserpic acid methyl ester in tissues, blood, intestinal contents and excreta of rats. Both of these were inactive pharmacologically. Kohli *et al.*[94] studied absorption, distribution and excretion of reserpine.

Many other indigenous plants were screened for hypotensive or ataraxic effects in the wake of the success of Rauwolfia serpentina. Sheth and Kekre [95] reported the hypotensive effect of aqueous, oil free, extracts of *Nardostachys jatamansi*. Vakil [96] also published his reports on clinical trial with the same drug. Bose *et al.*[97,98] further investigated the pharmacodynamics of various fractions of *Nardostachys jatamansi*. The total alkaloids and alcoholic fraction induced a prolonged fall of B. P. comparable to serpentine. In addition they showed a spasmolytic action on gut, uterus, bronchial muscle and frog rectus, a negative chronotropic action on heart and sedative action on C. N. S. in rat and pigeon like R. S. They produce inhibitory effects on respiration of brain, heart and liver tissues of rats. Arora and Lal [99] investigated the hypotensive action of Jatamansi ketone and it has been shown to block proprioceptive blood pressure regulating reflexes. Gujral [100] reported the hypotensive effect of essential oil and crystalline principle from *Carum roxburghianum* on normal and hypertensive rats. Agarawal *et al.*[101] noted sedative, hypotensive and negative chronotropic effects with alcoholic extracts of *Acorus calamus* Linn. roots and rhizomes. Gaitonde *et al.*[102] carried out pharmacological studies with Malakanguni, an indigenous ataractic agent. Chopra *et al.*[103] isolated a hypotensive alkaloid from the root bark of *Lochnera rosea* Linn. (Rattanjot) which has been shown to be identical with serpentine.

Cardiovascular System

Arora and his co-workers examined many drugs for their antiarrhythmic activity. Chloroquin,[104] pamaquin, primaquin [105] and a ortho substituted benzoic acid ester of dialkyl aminoalkanol, MCNA. 29.11 [106] were found to be more potent than quinidine in many tests. Amodiaquin,[107,108] essential oil of *Nordostachys jatamansi*,[109] tridiurecaine [110] and antimalarials proguanil, supazine and daraprim [111] were found to possess an activity weaker than that of quinidine. Arora *et al.*[112] studied the SAR of cinchona alkaloids with regard to their negative inotropic effect on amphibian and mammalian hearts. Quinoline ring was found to be responsible for negative inotropic effects. Alkoxyl substitution at C6 was also significant and the activity increased with the size of this substitution. In investigating negative inotropic effects of chloroquine and camoquin, Agarwal and Arora [113] found that both had an anticholinergic action on cardiac and smooth muscle and both blocked the cardio inhibitory effects of peripheral vagal stimulation.

Dandiya and Arora [114] reported a direct depressant action of a dealcoholised extract of *Onomia bracteatum.* It also lowered blood pressure and relaxed small intestine. Sinha [115] found that procainamide had stronger antiacetylcholine action than procaine on frog's rectus but was weaker in atropine like, antihistaminic and antinicotinic properties. Bhatt *et al.*[116] showed that saponins of fruits of *Luffa echinata Roxb.* and *Trigonelia foenum graecum* caused a fall in blood pressure due to both parasympatomimetic and direct effects on blood vessels. In addition the former had a diuretic effect and the later a direct stimulant effect on myocardium. Rindani and Merchant [117] showed that cooled perfused heart was not inhibited by vagal stimulation or by acetylcholine. Rindani and Chavan [118] studied the effect of cortisone and DOCA on isolated frog heart. Both of them inhibit cardiac contractions.

Arora and his co-workers studied the effects of several drugs on automaticity of sinoauricular and auriculoventricular nodes. Barbiturates [119] had both accelerator and inhibitor effects on heart rate. The former was due to depression of nervous cardio-inhibitory influences and the latter due to direct depressant effect on cardiac rhythmicity. Das and Arora [120] found that thiopentone directly depressed impulse generation in cardiac pacemaker. It also antagonised cardio accelerator and pressor actions of adrenaline and noradrenaline. In a subsequent study [121] it was shown to have a mild cardio vagus depressant effect. Thiopentone and acetylcholine mutually potentiated the actions of one another. Atropine reduced the hypotensive but not the cardiodepressant effects of thiopentone. Das and Arora [122] also studied the automaticity of A. V node in respect to its response to autonomic agents and compared it with S. A. node in dogs. No qualitative difference was detected in effect of drugs at the two sites. A. V.

node responded more to acetylcholine and S. A. node to atropine. Singh [123] studied the action of chloroform, ether and ethyl chloride upon impulse generation in dog's heart. The rate of impulse generation in presence of S. A. rhythm was accelerated by ether and ethyl chloride whereas chloroform produced slight initial stimulation followed by strong inhibitory action. The accelerator effect of ether and ethyl chloride was due to central depression of cardio inhibitory centre. The automaticity of A. V. node was more susceptible to depressant action of these agents.

Maiti [124, 125] isolated Kukscine hydrochlor from *Vernonia cinera*. The drug increased tone and amplitude of contraction of cardiac muscle from various species. In higher doses the rate was slowed, P-R interval prolonged and coronary flow increased. It also caused a contraction of isolated toad rectus muscle and increased its response to acetylcholine. Sanyal and Saunders[126] reported that a positive inotropic response occurred with ouabain in both fresh and hypodynamic strips of guinea pigs auricles. Mishra [127] screened indigenous drugs for cardiotonic effects Four drugs, *Vanda roxburghii*, *Ipomea digitata*, *Picrorhiza kurrooa* and *Cerbera odollum* were found to possess inotropic activity. Partial chemical purification of the active principle was done in each case. Rangaswamy and Rao [128] isolated two new digitaloid glycosides, Thevetia substance A and Thevetia substance B from seed kernels of *Thevetia neriifolia Juss.*

Pradhan *et al.*[129] studied the action of drugs of diverse pharmacological nature on the carotid blood pressure of mouse. Gupta [130] compared the vasomotor response to afferent vagal stimulation with the carotid occlusion response when used for investigating the site of action of hypotensive drugs. The vagal response was found to be definitely superior to the corotid occlusion response. Kulsreshtha [131] found that strychnine, neostigmine, d-tubocurarine (in nonpentobarbitalised cats) and hyoscine potentiated, while mephenesin, d-tubocurarine, pethidine, ganglion blocking agents and adrenergic blocking agents depressed the spinal compression vasomotor response in spinal cord ligated cats. Jindal [132] investigated the effects of quinine, proguanil and chloroquine on cardiovascular responses of adrenaline and acetylcholine in dogs. These drugs decreased the activity of acetylcholine on cardiovascular system to a varying degree. Quinine and proguanil decreased the pressor effects of adrenaline while chloroquine potentiated them. Sethi[133] found alkaloidal extract of *Boerhavia diffusa* Linn. (Punarnava) to be an effective coronary dilator. Gujral and Dhawan[134, 135] investigated the effects of many drugs on tourniquet shock in rats. Heparin, chlorpromazine, ergotoxine and atropine afforded significant production. Adrenaline given during early stages of shock hastened the death but given during later stages it prolonged survival period. Mukherjee and Werner[136] studied the biological effects produced by two types of plasma expanders, dextran and polyvinylpyrrolidine, of different molecular weights in the blood stream of dial anaesthetised rhesus monkeys. The main effects were reduction in plasma volume, total circulating protein and R. B. C. and increase in extracellular fluid volume.

Smooth Muscles

G. I. Tract: Gujral and Saxena[137] screened aqueous extracts of thirty-two indigenous drugs for their spasmolytic effect on isolated loops of rabbits intestine. Six of the drugs were very active, *Pinus deodara* being the most active. Vishwakarma and Sinha[138] studied the effects of oxyphenonium, hexamethonium and probanthine on gastric acid secretion of rats under anaesthesia. Oxyphenonium had no effect on spontaneous gastric secretion but inhibited both histamine and pilocarpine induced secretion. Probanthine inhibited only the pilocarpine induced secretion while hexamethonium had no effects on either. Lahiri[139] found that DOCA significantly decreased the resting as well as histamine induced gastric secretion particularly chloride secretion.

Biliary Tract : Ramprasad and Sirsi[140–143] published a number of papers on *Curcuma longa* and its active pigment, sodium curcuminate. Its most important action was stimulation of biliary secretion. The choleretic action was not so marked with the essential oil. The concentration of solids was decreased but it was compensated by increase in volume. It had a relaxant action on the gut without abolishing normal movements. It had a low toxicity and no adverse effects on liver, kidney, blood or uterus. It was shown to possess a specific antibacterial action against *Micrococos pyogenes* var. *aureus*.

Uterus : Joseph and Jindal [144] investigated the effects of some antimalarial drugs on isolated uterus of rat and guinea pig. Small doses of quinine and chloroquine had a stimulant action. Amodiaquin and bigger doses of quinine, proguanil and chloroquine had an antioxytocic effect against posterior pituitary. Sur *et al.*[145] studied the pharmacology of *Daemia extensa*. The ethyl acetate soluble fraction was most active. It caused contraction of uterus of intact animals and of isolated uterus of rabbits and guinea pigs. In addition it had a stimulant action on intestine, seminal vesicle and blood vessels.

Bronchial Tree : Bhattacharya [146] tested several quarternary derivatives of 2, 2, diphenyl, 4 diisopropyl amino-butyramide against acetyl-choline and neostigmine induced bronchospasm in isolated perfused guinea pig lung. Bhattacharya [147] conducted antagonistic studies against 5-HT on the same preparation. Adrenaline and isopropyl arterenol were the most effective antagonists to 5-HT induced bronchospasm. LSD also was an effective antagonist. DHE_{45}, dibenamine and regitine also showed mild antagonistic effect. Atropine and antihistaminics were ineffective. Hameed *et al.*[148] isolated a water soluble fraction Vasakin from the leaves of *Adhatoda vesica*. It caused considerable and persistent broncho-dilation. In addition it had antitussive and expectorant actions. Chakravarty *et al.*[149] studied central effects of some antitussive drugs on cough and respiration in decerebrate and pentobarbitalised cats using sterotaxic technic.

Metabolic Disorders and Vitamins

Diabetes : Gujral *et al.*[150] showed that insulin could be satisfactorily absorbed from the bronchial tree of rabbits and hinted the possibility of using aerosol as a new route of administration of insulin in diabetics. Joseph and Doctor [151] failed to find any blood sugar lowering effect of aqueous and alcoholic extracts of leaves of *Vinca rosea* given orally and parentrally to normal, hyperglycaemic or alloxan diabetic dogs. Sepaha and Bose [152] reported a lowering of blood sugar with *Pterocarpus marsupium* and seeds of *Eugenia jambolina*. Mukherjee and his co-wokers published a number of papers about alloxan diabetes in rabbits. Glucose, fructose and mannose were found to give immediate protection against diabetogenic action of alloxan and to prevent the fall of blood glutathione.[153] Sodium-β-glycerophosphate had both protecting and curative effects.[154] Both glucose and sodium-β-glycerophosphate gave better results in combination with oestrogens.[155] Glucose and glycerophosphates were found to prevent the rise in phosphatase activity of liver but not the fall in kidney and serum phosphatase activity caused by alloxan.[156] Protection was also afforded by vitamin K and E but best results were obtained by a combination of vitamin K and E.[157] Mukherjee *et al.*[158] studied the probable mode of action of carbutamide. They conclude that it probably acts at some enzymatic level in liver and potentiates the action of insulin. In addition it was also shown to cause damage to α-cell of pancreas resembling cobalt chloride in some respects.

Atherosclerosis : Chakravarty and his co-workers published a number of papers on experimental atherosclerosis during this period. Atherosclerosis was induced in rabbits by feeding cholesterol in cotton seed oil.[159] It was seen that blood cholesterol level was lower in rabbits fed on coconut oil than in those fed with cotton seed or ground nut oil.[160] Krishna *et al.*[161] also studied the effect of coconut and ground nut oils on serum protein and lipoprotein pattern in experimental atherosclerosis. Combined thyroid and oestrogen therapy yielded better results in regression or cholesterol atherosclerosis in rabbit's coronary arteries and aorta than treatment with either of them alone.[162] Similarly combinations of vitamin B_{12} and ascorbic acid produced better results than the use of either alone.[163]

Vitamins : Rao *et al.*[164] administered an oral supplement of 20-25 μg. of vitamin B_{12} daily for 14-15 weeks to undernourished Indian children without noticing any demonstrable effect on growth or nitrogen retention in these children. Dixit *et al.*[165] reported a new microbiological method for assay of serum vitamin B_{12} using

Euglena gracilis. Altekar *et al.*[166] found that high doses of vitamin B_{12} given intramuscularly increased urinary excretion of N_1-methylnicotinamide in human beings thus supporting the interrelationship of B_{12} and transmethylation reactions. Fatterpaker *et al.* investigated the role of folic acid and vitamin B_{12} in transmethylations.[167-170] Deficiency of either was shown to impair formation and excretion of creatine. Together their effects were additive and B_{12} probably promoted better utilisation of folic acid. There was a decrease of transmethylation reactions in deficiency of folic acid due to labile methyl drain to formate. Folic acid deficiency also influenced synthesis of N_1-methylnicotinamide and this was partially prevented by methanol. Administration of methanol and serine however did not change liver levels of choline, methionine or phosphocreatinines in folic acid deficient mice. They concluded that folic acid might be responsible for biosynthesis of ethanolamine moiety of choline while methyl synthesis from precursors was more directly influenced by B_{12}. De [171] reported a new flourometric method for vitamin A assay. Pradhan *et al.*[172] reported a new natural source of vitamin A—the viscera and liver of *Polynemus indicus* (Dara fish). De and Chowdhary [173] studied lipotropic effects of acetylcholine. Subcutaneous injections of acetyl choline and eserine demobilised the high liver fat induced by carbon tetrachloride and also decreased fat in normal rat liver. They postulated that fatty infiltration might be due to non-availability of acetylcholine due to interference in its synthesis from choline. Radhakrishnamurthy and Sarma [174] studied the role of biotin in the biosynthesis of inositol.

Miscellaneous: Gujral and Saxena [175] compared the effect of some indigenous and modern remedies on formaline induced arthritis in rats. Phenylbutazone and cortisone were the most effective agents. Among the indigenous drugs *Glycyrrhiza glabra* gave best results. Saha and Chaudhuri [176] found a protective action of hydrocortisone against chronic argemone poisoning particularly against ascites formation. Rao [177] studied the effect of various fatty acid fractions of ground nut oil on calcium metabolism in normal growing rats. Inclusion of ten per cent ground nut oil (saturated and unsaturated fatty acid fractions) in diet increased the utilisation of calcium in young growing rats by promoting absorption. Nath *et al.*[178] showed that addition of 2 per cent methionine to sulphydryl deficient diet prevented hyperglycemia caused by repeated injections of acetoacetate to rabbits whereas lower concentrations were ineffective. Tata [179] found that whereas both brain and muscle had deiodinating enzymes required for the metabolism of thyroxine and triidothyronine, the deaminating activity was only present in brain.

Antifertility Agents

Sanyal and his co-workers have extended their studies on the antifertility effect of metaxylohydroquinone (mXHQ), the active constituent of *Pisum sativum* Linn. seeds. mXHQ has been shown to have an antivitamin E effect on the testes of rats.[180, 181] In human trials mXHQ has been shown to reduce fertility by 50-60% [182, 183] and to be useful in functional uterine bleeding.[184] The drug did not show any deleterious effect on blood counts, B.P., etc. in human trials.[185] They have also synthesised 2 : 6 diethyl hydroquinone (DEHQ),[186] analogue of mXHQ which has anti-estrogenic, anti-progestational and anti-chorionic gonadotrophin activities on female rats.[187] 3 : 5 dimethyl phenoxyacetic acid and 2 : 6 dimethyl phenoxyacetic acid have also been prepared as substitutes for mXHQ.[188] The former enhances the activity of estrogen on uterus while the latter diminishes it.[189]

Varma [190] screened nine indigenous drugs for their antifertility effects in laboratory animals. *Mallotus phillippinensis*, the most active amongst these, has been investigated further. The petroleum ether extract of the plant in doses of 50mg./100gm. orally produces 100 per cent sterility in rats. It has no estrogenic, progestational, or androgenic action nor does it antagonise any one of these sex hormones. It significantly prolongs the estrus cycle of rats in diestrus phase and prevents mating. These actions are reversible. It has been shown to have anti-chorionic gonadotrophic effect in rats. Further progress in this work will be watched with interest.

Gujral and Tiwari [191] compared the spermicidal activity of ten drugs on human spermatozoa. The three most active drugs in the series were phenyl mercuric acetate, phenol and p-diisobutylphenoxy-polyethoxy-ethanol. Bose and Chandran[192] reported estrogenic activity in the fixed oil of *Cicer arietinum* Linn. (Chana). Indira *et al.*[193] found estrogenic activity in the essential oil obtained from the tubers of *Cyperus rotundus* Linn.

Chemotherapy

Antibiotics: Bannerji and Sarkar[194] and Bannerji[195] failed to find any significant improvement in the growth of rabbits or guinea pigs with therapeutic amounts of aureomycin. Satoskar and Lewis[196] reported beneficial effects of antibiotic supplements in persons whose protein intake was deficient in quality or quantity. Chopra and Khajuria[197] demonstrated that viomycin had synergistic action with penicillin and chloramphenicol against *S. typhii*, *S. paratyphii* A & B and *E. coli*. Ghosh *et al.*[198] found that intramuscular injection of chloramphenicol in rabbits for twenty-one days had no effect on antibody titre of animals immunised with heat killed typhoid vaccine or on normal haemogram. Rangaswami *et al.*[199] reported isolation and characterisation of two mycothricin complexes having antibacterial and antifungal properties. Vora *et al*[200] isolated a new antibiotic X340 from a Streptomyces sp. and it was found to be active against many Gram positive organisms. Tirunarayanan and Sirsi reported new antibiotics from *Fusarium oxysporum*[201] and *Fusarium avenaceum.*[202]

Gupta *et al.*[203] found that a new antibiotic X29c isolated from a non pigmented strain of *Penicillium notatum* Westling (29c) compared favourably with other well known antibiotics against common pyogenic organisms. Mazumdar and Bose[204] isolated a number of antifungal micro-organisms from Indian fruits and vegetables. Poonawala *et al.*[205] screened 304 cultures of fungi from 34 locations for antibiotic activity and many of them gave promising results. Shete and Vora[206] screened 311 soil actinomycetes for antibacterial activity.

Antibacterial Substances From Plants: Das *et al.*[207, 208] continued their work on Pterygospermin—antibiotic principle from *Moringa pterygosperma*—and related agents. They tested about twenty related compounds to find out SAR of antibacterial activity and investigated pharmacological actions of Pterygospermin. Sen Gupta *et al.*[209] studied the pharmacological effects of a vibriocidal principle Athomin (GL5U) from the root bark of *Moringa pterygosperma.* Kamat and his co-workers continued their investigations on pristimerin—the antibiotic principle from the plant *Pristimera indica.*[210] It was active against common Gram positive organisms and had a specific action against viridans streptococci. It was shown to have a carotenoid structure. They also prepared a number of ortho and paraquinones and compared their activity with pristimerin.[211] Only the orthoquinones were active. Rao and Sirsi [212] found that triketo hydrindene hydrate inhibited many organisms including *M. tuberculosis.* In addition it had a relaxant effect on all smooth muscles. Patel and Trivedi [213] showed that aqueous and dealcoholised extracts of the dried herb of *Enicostema littorale* were effective against a number of Gram positive and Gram negative organisms, particularly *E. coli, S. typhii, C. diphtheriae* and *M. pyogenes.* Satwalekar *et al.*[214] studied Kinos of four Eucalyptus species for their antibacterial and antifungal activity. They were particularly effective against Gram positive organisms. An amorphous active principle citriodorol was isolated. Kamat *et al.*[215] isolated an antistaphylococcal principle from *Vinca rosea.* Murthy and Sirsi [216] studied the antibacterial, antitubercular and antimalarial effects of Nimbidin, the active constituent of *Melia azadirachta* (Neem, Margosa). Other plants shown to possess antibacterial activity include *Bragantia wallichii,*[217] *Anisochilus carnosus,*[218] *Cassia fistula, tora* and *obovata,*[219, 220] garlic [221] and jute.[222] Kurup [223] screened thirty indigenous plants for antibacterial activity.

Antitubercular Substances: Many papers were published by Gupta and Vishwanathan on the antitubercular activity of indigenous drugs. These included volatile oils of *Ocimum sanctum,*[224] *Allium cepa* and *A. schoenoprasum,*[225] proliferin and variecolin from *Aspergillus proliferans* and *A. variecolor* respectively [226] and active principles from betel leaves, *Tinospora cardifolia, Ocimum carum* and *Ammorphophalus campanula-*

tus.[227] They also showed that cepharanthine and allicin had synergistic effects with streptomycin and chloramphenicol.[228] Chopra and Chopra[229] found that the volatile oil of *Alpinia galanga* and oil of *Acorus calamus* had antitubercular properties. The former was active against streptomycin resistant strains also. They were also active against some other organisms. Rao and Seshadri[230] studied *in vitro* tuberculostatic activity of some naturally acting quinones. Naphthoquinones were most active. Poplia and Vora[231] found that quinoline hydrazides were, in general, devoid of any outstanding *in vitro* tuberculostatic activity. Mukherji *et al.*[232] examined certain cyano-aliphatic acid hydrazides, their hydrazones and related compounds for *in vitro* activity against tubercle bacilli in an attempt to determine possible SAR. P-ethyl-p′-amino-diphenyl sulphone (SN 44) and p-isobutyl-p′-amino-diphenyl sulphone (SN 47) were found to be effective in guinea pigs infected with streptomycin sensitive and resistant strains of *M. tuberculosis var. hominis*,[233] and to be comparable with streptomycin sulphate and isonicotinic acid hydrazide.[234] S. N. 44 was found to have additive effects with dihydrostreptomycin[235] and synergistic effect with isoniazid[236] in experimental tuberculosis of guinea pigs. Chatterjee and Poddar[237] showed a preferential uptake of S^{35} labelled DDS by affected skin of leprosy patients.

Antimalarials: Jindal[238] published his preliminary experiences of treatment of malaria with quinine-calcium glucogalacto gluconate. Clinical cure was observed in 75 per cent cases in both B. T. and M. T. malaria. Earlier he reported that the drug caused lesser fall of B. P. of dogs than quinine and in large doses was a cardiac stimulant.[239] He suggested it to be a safe drug for parentral administration. Grover[240] obtained good results in the treatment of acute attacks with an indigenous remedy, Apacine (combination of *Achyarauth aspara* and *Cines lectularius*). Dutta *et al.*[241] found Dichora febrifuge and a synthetic hydrangea alkaloid, 1698L (a quinazolone derivative) to have some antimalarial action in mice and in humans. Misra *et al.*[242] screened ninety one potential antimalarial compounds against blood induced *P. gallinaceum* infection in 7-day old chicks. Dihydrotriazines were the most promising while some of the sulfabiguanides, thiopegenes and N′-aryl-N^5-alkyl-biguanides were also active. Bami[243] tested several dihydrotriazines in a similar way. 6 : 6 dimethyl derivatives were more active than their methyl-ethyl analogues. Ray *et al.*[244] showed that 1-(p-bromophenyl) 2 : 4-diamino-6 : 6-dimethyl-1 : 3 : 5-triazine was the active metabolite of bromguanide. Datta and Basu[245] showed that several antimalarial drugs, *i. e.* pentaquin, chloroquin, quinoline and quinine inhibited pyruvate oxidation of mice liver homogenates. They concluded that probably the quinoline nucleus was responsible for the action of drugs on enzymes of the tricarboxylic acid cycle.

Amebicides : Kaushiva[246] tested 18 derivatives of quinoline and quinaldine for their activity against *Entamoeba histolytica* Quinaldines were found to be more active than quinoline derivatives. The activity of two quinaldines (R-22 and R-26) was comparable to that of emetine. Kaushiva and Pujari[247] screened twenty-eight arsenic derivatives of thiazolidone and thiazole against *E. histolytica.* Arsenothiazoles were the most active compounds in the series. In a subsequent study Kaushiva[248] tested *in vivo* amoebicidal activity of fifty-two substituted polymethylene diamines. 1-substituted amino 9-di-n-butyl-aminononanes were more active than the corresponding morpholino or piperidinonanes. Maximum activity was attained by introducing n-hexyl-n-dodecyl radicals. Iyer *et al.*[249] synthesised some 4-substituted amino-8-hydroxy and 8-methoxy quinazolines and 3-substituted 8-hydroxy- and 8-methoxy-4-quinazolones as potential amoebicides on the basis that chelation played a vital role in the antipathogenic activity of 8-oxyquinolines. Kaushiva and Ghatak[250] showed that increase in alkaline phosphatase activity of rat caecum as a result of amoeba-bacteria inoculation could be inhibited by emetine and conesine, the former being more potent.

Miscellaneous : Bannerji[251] treated ten cases of tropical pulmonary eosinophilia by an aerosol of diethylamine acetarsol with good results. Bhaduri *et al.*[252] reported that Cardol (a constituent of cashew nut shell liquid) was a good anthelminthic against Ascariasis, Necator and Trichuris infections. Alfonso and Khorana[253] evaluated cinnamic acid and cinnamic acid aldehye derivatives as antibacterials. Singh and Singh [254] found that 2-iodo-6-methoxy, 2-iodo-7 methoxy and 3 methoxy-6-chloro,-diamino-acridines were equally potent and less toxic antiseptics than proflavine or acriflavine. Lahiri and Guha [255] investigated ten new compounds, generally of phenyl or diphenyl linkages for antibacterial property. One of them, para aminophenone was as effective as oxytetracycline in infections caused by *Vibrio cholerae*, *Shigella shiga* and *Salmonella typhii*. Mukerjea [256, 257] and Mukerjea and Tripathi [258] found ether extract of *Milleti pachycarpa* seed and ether and petrolem extracts of *Annona squamora* seed to be good contact insecticides against *Musca nebulo*, *Bombyx mori*, and *Tribolium castaneum*. Dixit *et al.*[259] evaluated insecticidal activity of solvent extracts and the steam volatile principle of the rhizomes of *Acorus calamus* Linn. Chopra *et al.*[260] screened about forty plants from Kashmir flora for possible insecticidal and insect repellant activity. Some of the plants gave hopeful results against *Aedes aegypti* and *Musca nebulo*.

Miscellaneous

Diuretics : Gujral *et al.*[261] screened thirty-three indigenous drugs for their diuretic activity in rats with reference to urea as standard. Four of them, *Saccharum officinale*, *Nardostachys jatamansi*, *Oroxylum indicum* and *Viola odorate* possessed good activity. Bannerjee *et al.*[262] made a clinical trial of the seeds of *Dolichos biflorus* as a diuretic. The results were not very good. Bhide and Sheth [263] studied the diuretic activity of alcohol ether fraction of *Cassia occidentalis* in anaesthetised hydrated dogs. Chaudhury and Sen [264] reported the effects of *Boerhaevia diffusa* Linn. on diuresis and renal enzymes. Das [265] failed to find any urinary calculi dissolving effect of *Didymocarpus pedicellata* and *Saxifraga lingulata* in rats,

Anticoagulants: Pillai *et al.*[266] isolated a blood anticoagulant factor from the latex of *Carica papaya*. It was found to cause destruction of thrombin activity and to inhibit conversion of prothrombin to thrombin. Pillai *et al.*[267] tested seven plants for anticoagulant activity. Aqueous extracts from the latex of *Carica* *papaya* and the fruit juice of *Citrullus colosynthis* were found to contain anticoagulant factors. Sen and Sen [268] found that intramuscular injections of niacin caused an increased coagulability of blood in normal rabbits probably by an increase in ionisable calcium and platelet count.

Snake Venoms: Gujral and Dhawan [269] tested the effect of eight drugs modifying absorption on death caused by cobra venom in rats. ACTH, cortisone and rutin afforded a significant degree of protection. Ganatra *el al.*[270] also reported that hydrocortisone gave a significant protection against Russel's viper venom poisoning in mice. Ojha [271] found that BAL significantly reduced the rate of mortality in experimental viper venom poisoning in guinea pigs and gave complete protection when smaller doses of venoms were used. He thought that the protection may be due to presence of SH groups in BAL.

Histamine and Related Drugs: Gujral *et al.*[272, 273] compared eleven antihistaminic drugs in guinea pigs on the basis of protection against histamine aerosol. Chlortrimeton was found to be most potent. Their duration of action was also studied and the results were in conformity with those of other investigators. Sirsi and Rao [274] showed that the essential oil of *Anisochilus carnosus* had antihistaminic action *in vitro*, prevented contracture of sensitised ileum to antigenic stimulation and caused a relaxation of intestines but was unable to inhibit the response of sensitised guinea pig uterus to egg white. Bhattacharya and Lewis [275] showed that histamine liberators could also cause a release of 5-HT from perfused tissues.

Acknowledgments

The authors are grateful to Drs. J. C. Malhotra and K. K. Tangri for their help in the preparation of this review.

REFERENCES

1 Gujral, M. L., Kohli, R. P. & Saxena, P. N, (1955), Medicine, **2**, 29.

2 *Idem.* (1955), Indian J, Med. Sci., **10**, 872.

3 Gujral, M. L., Saxena, P. N. & Tiwari, R. S. (1956), *Ibid.*, **10**, 878.

4 Gujral, M. L., Sareen, K. N, & Kohli, R. P, (1957), Indian J. Med. Res,, **45**, 207.

5 Gujral, M. L, & Dhawan, B. N. (1957), Indian J. Physio, & Pharmacol., **1**, 30.

6 Mukherjee, K. N. & Chakravarthy, N. K. (1956), Bull. Calcutta Sch. Trop. Med., **4**, 71.

7 Chakravarthy, N. K., Woodbury, D. M, & Goodman, L. S. (1956), J. Pharmacol. & Exp. Therap., **103**, 54.

8 Mondkar, U. P., Bharucha, E. P. & Vahia, N, S. (1957), J. Postgrad. Med., **3**, 244.

9 Gujral, M. L., Saxena, P. N. & Dhawan, B. N, (1956), Indian J. Med. Res., **44**, 473.

10 Ahmad, A, (1957), Indian J, Med. Sci., **11**, 64.

11 Gujral, M. L., Saxena, P. N. & Khanna, B. K. (1956), J. Indian Med. Prof., **3**, 1098.

12 Gujral, M. L., Saxena, P. N. & Kulsreshtha, J. K. (1956), *Ibid.*, **3**, 1220,

13 *Idem.* (1956), Indian J. Med. Sci., **10**, 625.

14 *Idem.* (1956), J. Ass. Phys. Ind., **4**, 451.

15 *Idem.* (1956), J. Ind. Med. Prof., **3**, 1141.

16 Ahmad, A. & Goswami, R. (1956), Indian J. Med. Sci., **10**, 792.

17 Das Gupta, S. R. & Hausler, H. F. (1955), Bull. Calcutta Sch. Trop, Med., **3**, 69.

18 Malhotra, C. L. & Mehta, S. (1957), Indian J. Physiol. & Pharmacol., **1**, 190.

19 Das Gupta, S. R. (1957), J. Indian Med. Ass., **28**, 347.

20 Das Gupta, S. R., Chatterjee, A. & Ray, H. N. (1956), Bull. Calcutta Sch. Trop. Med., **4**, 124.

21 Das Gupta, S. R, & Mukherjee, K. L. (1956), *Ibid.*, **4**, 123.

22 Rajgopalan, V. (1955), J. Indian Med. Ass., **25**, 204.

23 Lahiri, S, C. (1957), A Study of Some Cardiavascular Effects of Chlorpromazine., M. D. Thesis, Lucknow University.

24 Arora, R. B. & Madan, B. R. (1955), Indian J. Physiol. & All. Sci., **9**, 171.

25 Das Gupta, S. R. & Hausler, H. F. (1955), Bull. Calcutta Sch. Trop. Med,, **3**, 112.

26 Das Gupta, S. R. (1955), *Ibid.*, **3**, 17.

27 Das Gupta, S. R, & Hausler, H. F. (1955), *Ibid.*, **3**, 113,

28 Gujral, M. L. & Khanna, B. K. (1957), J. Sci. Industr. Res., **16C**, 11

29 Saxena, P. N. & Gupta, G. P. (1957), Indian J. Med. Res., **45**, 319.

papaya and the fruit juice of *Citrullus colosynthis* were found to contain anticoagulant factors. Sen and Sen[268] found that intramuscular injections of niacin caused an increased coagulability of blood in normal rabbits probably by an increase in ionisable calcium and platelet count.

Snake Venoms: Gujral and Dhawan[269] tested the effect of eight drugs modifying absorption on death caused by cobra venom in rats. ACTH, cortisone and rutin afforded a significant degree of protection. Ganatra *el al.*[270] also reported that hydrocortisone gave a significant protection against Russel's viper venom poisoning in mice. Ojha[271] found that BAL significantly reduced the rate of mortality in experimental viper venom poisoning in guinea pigs and gave complete protection when smaller doses of venoms were used. He thought that the protection may be due to presence of SH groups in BAL.

Histamine and Related Drugs: Gujral *et al.*[272, 273] compared eleven antihistaminic drugs in guinea pigs on the basis of protection against histamine aerosol. Chlortrimeton was found to be most potent. Their duration of action was also studied and the results were in conformity with those of other investigators. Sirsi and Rao[274] showed that the essential oil of *Anisochilus carnosus* had antihistaminic action *in vitro*, prevented contracture of sensitised ileum to antigenic stimulation and caused a relaxation of intestines but was unable to inhibit the response of sensitised guinea pig uterus to egg white. Bhattacharya and Lewis[275] showed that histamine liberators could also cause a release of 5-HT from perfused tissues.

Acknowledgments

The authors are grateful to Drs. J. C. Malhotra and K. K. Tangri for their help in the preparation of this review.

REFERENCES

1 Gujral, M. L., Kohli, R. P. & Saxena, P. N, (1955), Medicine, **2**, 29.

2 *Idem.* (1955), Indian J, Med. Sci., **10**, 872.

3 Gujral, M. L., Saxena, P. N. & Tiwari, R. S. (1956), *Ibid.*, **10**, 878.

4 Gujral, M. L., Sareen, K. N, & Kohli, R. P, (1957), Indian J. Med. Res,, **45**, 207.

5 Gujral, M. L. & Dhawan, B. N. (1957), Indian J. Physio, & Pharmacol., **1**, 30.

6 Mukherjee, K. N. & Chakravarthy, N. K. (1956), Bull. Calcutta Sch. Trop. Med., **4**, 71.

7 Chakravarthy, N. K., Woodbury, D. M. & Goodman, L. S. (1956), J. Pharmacol. & Exp. Therap., **103**, 54.

8 Mondkar, U. P., Bharucha, E. P. & Vahia, N, S. (1957), J. Postgrad. Med., **3**, 244.

9 Gujral, M. L., Saxena, P. N. & Dhawan, B. N, (1956), Indian J. Med. Res., **44**, 473.

10 Ahmad, A, (1957), Indian J, Med. Sci., **11**, 64.

11 Gujral, M. L., Saxena, P. N. & Khanna, B. K. (1956), J. Indian Med. Prof., **3**, 1098.

12 Gujral, M. L., Saxena, P. N. & Kulsreshtha, J. K. (1956), *Ibid.*, **3**, 1220,

13 *Idem.* (1956), Indian J. Med. Sci., **10**, 625.

14 *Idem.* (1956), J. Ass. Phys. Ind., **4**, 451.

15 *Idem.* (1956), J. Ind. Med. Prof., **3**, 1141.

16 Ahmad, A. & Goswami, R. (1956), Indian J. Med. Sci., **10**, 792.

17 Das Gupta, S. R. & Hausler, H. F. (1955), Bull. Calcutta Sch. Trop, Med., **3**, 69.

18 Malhotra, C. L. & Mehta, S. (1957), Indian J. Physiol. & Pharmacol., **1**, 190.

19 Das Gupta, S. R. (1957), J. Indian Med. Ass., **28**, 347.

20 Das Gupta, S. R., Chatterjee, A. & Ray, H. N. (1956), Bull. Calcutta Sch. Trop. Med., **4**, 124.

21 Das Gupta, S. R, & Mukherjee, K. L. (1956), *Ibid.*, **4**, 123.

22 Rajgopalan, V. (1955), J. Indian Med. Ass., **25**, 204.

23 Lahiri, S. C. (1957), A Study of Some Cardiavascular Effects of Chlorpromazine., M. D. Thesis, Lucknow University.

24 Arora, R. B. & Madan, B. R. (1955), Indian J. Physiol. & All. Sci., **9**, 171.

25 Das Gupta, S. R. & Hausler, H. F. (1955), Bull. Calcutta Sch. Trop. Med,, **3**, 112.

26 Das Gupta, S. R. (1955), *Ibid.*, **3**, 17.

27 Das Gupta, S. R, & Hausler, H. F. (1955), *Ibid.*, **3**, 113,

28 Gujral, M. L. & Khanna, B. K, (1957), J. Sci. Industr. Res., **16C**, 11

29 Saxena, P. N. & Gupta, G. P. (1957), Indian J. Med. Res., **45**, 319.

30 *Idem*, (1957), J. Indian Med. Prof., **4**, 1553.

31 Kulsreshtha, J. K. & Saxena, P. N. (1957), Indian J. Physiol. & Pharmacol., **1**, 204.

32 Shah, V. R. & Sheth, V. K. (1957), Indian J. Pharma., **19**, 253.

33 Gujral, M. L., Kohli, R. P., Bhargava, K. P. & Saxena, P. N. (1955), Indian J. Med. Res., **43**, 89.

34 Gujral, M. L., Saxena, P. N. & Kohli, R. P. (1955), *Ibid.*, **43**, 457.

35 Saxena, P. N. & Khanna, B. K. (1958), Indian J. Med. Res., **46**, 6.

36 Arora, R. B. & Sharma, V. N. (1955), J. Pharmacol. & Exp. Therap., **115**, 413.

37 *Idem.* (1956), Arch. int. Pharmacodyn., **104**, 388.

38 *Idem.* (1956), Indian J. Med. Sci., **10**, 197.

39 Sinha, Y. K. (1955), Indian J. Med. Res., **44**, 463.

40 *Idem.* (1957), J. Indian Med. Ass., **29**, 14.

41 Bhattacharya, B. K. & Atanackovic, D. (1955), Arch. int. Pharmacodyn., **104**, 275.

42 Ray, C., Kohli, J. D. & De, N. N. (1957), J. Sci. Industr, Res., **16C**, 33.

43 Rastogi, R. P., Khanna, N. M. & Dhar, M. L. (1956), *Ibid.*, **15C**, 177.

44 Lahiri, S. C. & Sen, K. N. (1956), Indian J. Physiol. & All. Sc., **10**, 27.

45 Sinha, K. N. & Rajapurkar, M. V. (1955), Indian J. Med. Res., **43**, 305.

46 Arora, R. B. (1955), Indian J. Med. Res., **43**, 311.

47 Arora, R. B. & Dandiya, P. C. (1956), *Ibid.*, **44**, 237.

48 *Idem*, (1956), J. Pharmacol. & Exp. Therap., **118**, 230.

49 Arora, R. B. & Das, P. K. (1956), Arch. Int. Pharcodyn., **107**, 202.

50 Subbu, V. & Subrahmanyam, S. (1956), Indian J. Med. Sci, **10**. 445.

51 Pradhan, S. N., Achinstein, B. & Shear, M. J. (1956), Proc. Soc. Expt. Biol. & Med., **92**, 146.

52 Roy, B. B. & Kuperman, A. S. (1955), *Ibid.*, **89**, 255.

53 Ahmed, A. & Taylor, N. R. W. (1957), J. Pharm. Pharmacol., **9**, 536.

54 Bose, B. C. & Gupta, G. S. (1956), Arch. Int. Pharmacodyn, **108**, 311.

55 Agarwal, S. L. & Harvey, S. C. (1956), J. Pharmacol. & Exp. Therap., **117**, 106.

56 Bhargava, K. P. & Borison, H. L. (1955), Fed. Proc., **14**, 319.

57 *Idem.* (1955), J. Pharmacol. & Exp. Therap., **115**, 464.

58 *Idem.* (1956), Fed. Proc., **15**, 401.

59 *Idem.* (1957), J. Pharmacol. & Exp. Therap., **119**, 295.

60 Das, N. N., Das Gupta, S. R., Mukherjee, K. L. & Werner, G. (1955), Indian J. Med. Res., **43**, 101.

61 Kohli, J. D., Balwani, J. H , Ray, C. & De, N. N. (1957), Arch. int. Pharmacodyn., **101**, 108.

62 Razdun, M. & Das, N. N. (1955), Indian J. Physiol. & Allied Sci., **9**, 147.

63 Mukherjee, K. L. & Werner, G. (1955), Bull. Calcutta Sch. Trop, Med,, **3**, 19.

64 Chatterjee, A. & Talapatra, S. K. (1955), J. Sci. Industr. Res , **14C**, 237.

65 Kothari, N. J., Rindani, T. H. & Naik, M. G. (1957), Arch. int. Pharmacodyn, **107**, 293.

66 Arora, R. B. & Madan, B. R. (1956), Indian J. Pharm , **18**, 247.

67 *Idem*. (1956), J. Pharm. & Exp. Therap., **117**, 62.

68 Arora, R. B. (1956), Arch. int. Pharmacodyn., **106**, 28.

69 Chatterjee, M. L. (1955), Bull. Calcutta Sch. Trop. Med , **3**, 15,

70 Chatterjee, M. L. & Hausler, H. F. (1955), *Ibid.*, **3**, 71.

71 *Idem*. (1955), Nature, Lond. **176**, 701.

72 Chatterjee, M. L. & De, M. S. (1957), Bull. Calcutta Sch. Trop. Med., **5**, 172.

73 Chatterjee, M. L. & Hausler, H. F. (1955), *Ibid.*, **3**, 70,

74 Chatterjee, M. L. & De, M. S. (1956), *Ibid.*, **4**, 127.

75 Chatterjee, M, L. & Hausler, H. F. (1955), *Ibid.*, **3**, 158.

76 Bannerjee, J. N. & Lewis, J. J. (1955), J. Pharmacol., **7**, 50,

77 Bannerjee, J. N. (1956), Indian J. Pharm., **18**, 265.

78 Chatterjee, M. L., De, M. S. & Seth, D. (1957), Bull. Calcutta Sch. Trop. Med,, **5**, 172.

79 Kuschke, H. J. & Frantz, J. (1955), Arch. Exp. Path, Pharmak., **224**, 269.

80 Schuler, W. (1955) Quoted from Bein, H. J. (1956), Pharm. Rev., **8**, 435.

81 Sirsi, M. & Tirunarayanan, M. O. (1955), Curr. Sci., **24**, 185.

82 Sirsi, M. & Rao, R. R. (1956), Indian Med. Record, **76**, 228.

83 Sirsi, M., Indira, M. & Rao, R. R. (1956), Curr. Sci,, **25**, 15.

84 Ram Prasad, C. & Sirsi, M, (1957), J. Indian Med. Ass., **28**, 307.

85 Rindani, T. H. & Antia, F. P. (1957), Indian J. Med. Sci., **11**, 479.

86 Kohli, R. P. (1957). Abstr. Symp. on Utilisation of Ind. Med. Plants, Lucknow, p. 34.

87 Khirwadkar, M. G. (1956), Indian J. Med. Sci., **9**, 162.

88 Bhattacharya, B. K. & Lewis, G. P. (1956), Brit. J. Pharmacol., **11**, 411.

89 Malhotra, C. L. & Siddhu, R. K. (1956), J. Pharmacol. & Exp. Therap., **116**, 123.

90 Chowhan, J. S. (1956), Antiseptic, **53**, 858.

91 Bose, B. C. & Vijayvargiya (1957), Curr. Sci., **26**, 383.

92 Ghosh, B. P. & Basu, R. K. (1955), Naturwissenschaften, **42**, 130.

93 Dhar, M. M., Kohli, J. D. & Srivastava, S. K. (1956), J. Sci. Industr, Res., **14C**, 179.

94 Kohli, J. D., Dhar, M. M. & Srivastava, S. K. (1956), *Ibid.*, **15C**, 167.

95 Sheth, V. K. & Kekre, M. S. (1956). Indian J. Med. Sci., **10**, 33.

96 Vakil, R. J. (1956), Indian Heart J., **8**, 133.

97 Bose B. G., Gupta, S. S., Vijayvargiya, R., Saifi, A. Q. & Bhatnagar, J. N. (1957), Curr. Sci., **26**, 278.

98 Bose, B.C., Gupta, S. S., Bhatnagar, J. N. & Vijayvargiya, R. (1957), Indian J. Med. Sci., **11**, 803.

99 Arora, R. B. & Lal, A. (1957), Abstr. Symp. on Utilisation of Ind. Med. Plants, Lucknow, p. 27.

100 Gujral, M. L. (1957), *Ibid.*, 33.

101 Agrawal, S. L., Dandiya, P. C., Singh, K. P. & Arora, R. B. (1956), J. Am. Pharmaceut. Ass., **45**, 565.

102 Gaitonde, B. B., Raiver, K. P., Shroff, F. N. & Patel, J. R. (1957), Curr. Med. Pract., **11**, 619.

103 Chopra, I. C., Jamwal, K. S., Pillay, P. P. & Santhakumari, T. N. (1957), Indian J. Med. Res., **45**, 467.

104 Arora, R. B., Sharma, V. N. & Madan, B. R. (1955), Indian J. Med. Res., **43**, 659.

105 Arora, R. B. & Madan, B. R. (1956), Arch. int, Pharmacodyn., **107**, 215.

106 Arora, R. B., Sharma, V. N. & Madan, B. R. (1956), J. Pharm. Pharmacol., **8**, 323.

107 Arora, R. B. & Madan. B. R. (1956), Indian J. Med. Res., **44**, 99.

108 Arora, R. B., Madan, B. R. & Pathak, R. K. (1956), *Ibid.*, **44**, 453.

109 Arora, R. B. & Madan, B. R. (1956), *Ibid.*, **44**, 258.

110 Arora, R. B., Sharma, V. N. & Madan, B. R. (1956), *Ibid.*, **44**, 271.

111 Arora, R. B. & Madan, B. R. (1956), *Ibid.*, **44**, 449.

112 Arora. R. B., Agarwal, S. L., Dandiya, P. C. & Singh, K. P. (1956), *Ibid.*, **44**, 645.

113 Agarwal, S. L. & Arora, R. B. (1956), *Ibid.*, **44**, 631,

114 Dandiya, P. C, & Arora, R. B, (1957), J. Am. Pharmaceut, Ass., **46**, 111.

115 Sinha, Y. K. (1955), Indian J. Med, Res., **43**, 453,

116 Bhatt, R. H., Khorana, M. I., Patel, J. R., Gaitonde, B. B. & Kekre, M. S. (1958), Indian J. Physiol. & Pharmacol., **21**, 309.

117 Rindani, T.H. & Merchant, R.C. (1957), Indian J. Med, Res., **45**, 363.

118 Rindani, T. H. & Chavan, M. H. (1955), Indian J. Physiol. & All. Sci., **9**, 134.

119 Arora, R. B. & Das, P. K. (1955), *Ibid.*, **43**, 643.

120 Das, P. K. & Arora, R. B. (1956), *Ibid.*, **44**, 637.

121 *Idem*, (1956), Indian I. Med. Sci., **10**, 955.

122 *Idem*, (1956), *Ibid.*, **10**, 255.

123 Singh, K. P. (1958), The Action of Chloroform, Ether and Ethylchloride upon Impulse Generation in the Dog Heart, M. Sc. Thesis, Rajasthan University.

124 Maiti, A. (1955), Indian J. Physiol. & All. Sci., **9**, 23.

125 *Idem.* (1955), *Ibid.*, **9**, 189.

126 Sanyal, P. N. & Saunders, P. R. (1957), Proc. Soc. Biol. Expt. Med., **95**, 156.

127 Mishra, S. S. (1956), A Pharmacological Study of Some Indigenous Cardiotonic Drugs. M. D. Thesis, Lucknow University.

128 Rangaswami, S. & Rao, E. V. (1957), Abstr. Symp. on Utilization of Indian Med. Plants, Lucknow, p. 22.

129 Pradhan, S. N., Achinstein, B. & Shear, M. J. (1955), J. Pharmacol. & Expt. Therap., **113**, 44.

130 Gupta, G. P. (1958), Effect of Drugs on the Vasomotor Response to Afferent Vagal Stimulation, M. D. Thesis, Lucknow University.

131 Kulsreshtha, J. K. (1958), Role of Spinal Cord in the Vasomotor Effects of Drugs, M. D. Thesis, Lucknow University.

132 Jindal, M. N. (1956), Indian J. Med. Res., **44**, 649.

133 Sethi, M. S. (1955), Indian Med. Gaz., **90**, 107.

134 Gujral, M. L. & Dhawan, B. N. (1957), J. Sci. & Industr. Res., **16C**, 104.

135 *Idem.* (1957), *Ibid.*, **16C**, 161.

136 Mukherjee, K. L. & Werner, G., *Ibid.*, **14C**, 70.

137 Gujral, M. L. & Saxena, P. N. (1955), J. Indian Med. Ass., **25**, 247.

138 Vishwakarma, P. & Sinha, Y. K. (1957), Indian J. Med. Res., **45**, 557.

139 Lahiri, S. C. (1955), J. Indian Med. Ass., **25**, 199.

140 Ram Prasad, C. & Sirsi, M. (1956), J. Sci. Industr. Res., **15c**, 239.

141 *Idem.* (1956), *Ibid.*, **15c**, 262.

142 *Idem.* (1957), *Ibid.*, **16c**, 108.

143 *Idem.* (1957), Indian J. Physiol. & Pharmacol., **1**, 136.

144 Joseph, A. D. & Jindal, M. N. (1957), J. Postgrad. Med., **3**, 225.

145 Sur, R. N., Nand, N. & De, N. N. (1957), Abstr. Symp. on Utilisation of Indian Med. Plants, Lucknow, p. 37.

146 Bhattacharya, B. K. (1955), Arch. int. Pharmacodyn., **104**, 285.

147 *Idem.* (1955), *Ibid.*, **103**, 357.

148 Hameed, K. A., Bakshi, V. N. & Delima, T. (1957), Abstr. Symp. on Utilisation of Indian Med. Plants, Lucknow, p. 31.

149 Chakravarty, N. K., Matallana, A. M., Jensen, R. & Borison, H. L. (1956), J. Pharmacol. Expt. Therap., **117**, 127.

150 Gujral, M. L., Saxena, P. N., Dhawan, B. N. & Kishor, K. (1955), J. Indian Med. Prof., **2**, 711.

151 Joseph, A. D. & Doctor, R. B. (1957), J. Postgrad. Med., **3**, 16.

152 Sepaha, G. C. & Bose, S. N. (1956), J. Indian Med. Ass., **27**, 388.

153 Mukherjee, S. K., De, N, N. & Mukherji, B. (1955), Indian J. Med, Res,, **43**, 149.

154 *Idem.* (1955), *Ibid.*, **43**, 463.

155 *Idem.* (1956), *Ibid.*, **44**, 59.

156 *Idem.* (1956), *Ibid.*, **44**, 415.

157 *Idem.* (1957), *Ibid.*, **45**, 23.

158 *Idem.* (1957), *Ibid.*, **45**, 387.

159 Chakravarthy, R. N., De, U. N. & Mukerji, B. (.955), Indian J, Med. Res., **43**, 79.

160 *Idem.* (1956), *Ibid*, **44**, 49.

161 Krishna, B., Chakravarthi. R. N. & Mukerji, B. (1957), *Ibid*, **45**, 549.

162 Chakravarti, R, N., De, U. N. & Mukerji, B. (1956), *Ibid.*, **44**, 683.

163 *Idem.* (1957), *Ibid.*, **45**, 315.

164 Rao, K. S., Ramnatham, M. K., Taskar, A. D. & Phansalkar, S. V. (1955), *Ibid.*, **43**, 276.

165 Dixit, C. H., Mody, B. M., Jhala, H. I., Parekh, J. G. & Ramasarma, G. B. (1956), Indian J. Med. Sci., **10**, 413.

166 Altekar, W. W., Chitre, R. G. & Gokhale, S. K. (1957), J. Postgrad. Med., **3**, 193.

167 Fatterpaker, P. Maratia, W. & Sreenivasan, A. (1955), Indian J. Med. Res., **43**, 43.

168 *Idem.* (1955), *Ibid.*, **43**, 337.

169 *Idem.* (1955), *Ibid.*, **43**, 343.

170 *Idem.* (1955), *Ibid.*, **43**, 349.

171 De, N. K. (1955), *Ibid.*, **13**, 391.

172 Pradhan, S. K., Marathe, V. G, & Arsiwala, S. M. (1956), J. Sci. Industr. Res., **15C**, 228.

173 De, H. N. & Chowdhury, A. N. (1955), Ind. J. Med. Sc., **9**, 608.

174 Radhakrishnamurthy, R. & Sarma, P. S. (1956), J. Sci. Industr. Res., **15C**, 231.

175 Gujral, M. L. & Saxena, P. N. (1956), Indian J. Med. Res., **44**, 657.

176 Saha, T. K. & Chaudhuri, R. N. (1956), Bull. Calcutta. Sch. Trop. Med., **4**, 7.

177 Narayana Rao, M. N. (1955), Indian J. Physiol. N. & All. Sc., **9**, 16.

178 Nath, M. C., Chakrabarti, C. H. & Nayudu, S. C. (1956), Proc. Soc. Biol. Expt. Med., **88**, 416.

179 Tata, J. R. (1957), *Ibid*,, **95**, 362.

180 Sanyal, S. N. (1955), Int. Med. Abstr. & Rev., **17**, 1.

181 *Idem.* (1955), *Ibid.*, **17**, 73.

182 Sanyal, S. N. & Ghosh, S. (1955), *Ibid.*, **18**, 101.

183 Sanyal, S. N. (1956), J. Med. & Int. Med. Abstr., **19**, 3.

184 *Idem.* (1955), Int. Med. Abstr. & Rev., **18**, 27.

185 Sanyal, S. N.. Banerjee, S. C. & Sen, J. (1955), *Ibid.*, **18**, 31.

186 Sanyal, S. N, & Guha Sarkar, S. S. (1956), J. Med. & Ind. Med. Abstr,. **20**, 125,

187 Sanyal, S. N. (1957), *Ibid.*, **21**, 1,

188 Sanyal, S. N. & Guha Sarkar, S, S. (1957) *Ibid* ., **21**, 49.

189 Sanyal, S N. (1957), *Ibid.*, **21**, 43.

190 Varma, D. R. (1958), An Experimental Study of Antifertility Effect of some Indigenous Drugs, M. D. Thesis, Lucknow University.

191 Gujral, M. L. & Tiwari, R, S. (1956), Uttar Bharti, **3**, 67.

192 Bose, J. L. & Chandran, K. (1955), J. Sci, Industr. Res., **14C** ., 128.

193 Indira, M., Sirsi, M., Radomin, S. & Dev, S. S. (1956), *Ibid.*, **15C**, 202.

194 Bannerji, D. & Sarkar, N, K. (1955), Bull. Calcutta Sch. Trop. Med. **3**, **124**, 1955.

195 Bannirje, D. (1956), *Ibid.*, **4**, 67.

196 Satoskar, R. S, & Lewis, R. A. (1955), Indian J. Med. Res , **43**, 414.

197 Chopra, I. C. & Khajuria, B. N. (1955), *Ibid.*, **43**, 129.

198 Ghosh, S. N., Bannerjee, G. Rudra, B. K. & Roy, A. N. (1956), Ann. Biochem. Expt, Med., **16**, 45.

199 Rangaswamy, C., Schaffner, C. P. & Waksman, S. A. (1956), Antib, & Chemo., **6**, 675.

200 Vora, V. C., Shete, K. & Dhar, M. M. (1957), J. Sci. Industr. Res., **16C**, 182.

201 Tirunarayanan, M. O. & Sirsi, M. (1955), Curr. Sci. **24**, 162.

202 *Idem.* (1957), J, Indian Inst. Sci., **39A**, 185.

203 Gupta, S, K., Shete, K. & Vora, V. C, (1955), J. Sci. Industr. Res,, **14C**, 142.

204 Majumdar, S. K. & Bose, S. K. (1955), *Ibid.*, **14C**, 126.

205 Poonawala, F. M , Fernandes, F, & Bhatnagar, S. S. (1956), *Ibid.*, **15C**, 242.

206 Shete, K. & Vora, V. C. (1956), *Ibid.*, **15C**, 124.

207 Das, B. R., Kurup, P. A. & Rao, P. L. N. (1957), Indian J. Med. Res., **45**, 191.

208 Das, B. R., Kurup, P. A., Rao, P. L. N. & Ramaswamy, A. S. (1957), *Ibid.*, **45**, 197.

209 Sen Gupta, K. P., Ganguli, N. C. & Bhattarcharjee, B, (1956), Antiseptic, **53**, 287.

210 Kamat, V. N., Fernandes, F. & Bhatnagar, S, S. (1955), J. Sci. Industr. Res., **14C**, 1.

211 Kamat, V. N., DeSa, J., Fernandes, F. & Bhatnagar, S, S. (1956), *Ibid.*, **15C**, 8,

212 Rao, R. R. & Sirsi, M. (1957), Indian J. Physiol. & Pharmacol., **1**, 45.

213 Patel, R. P. & Trivedi, Bhanumathi, M. (1957), Indian J. Med. Sci., **11**, 887.

214 Satwalekar, S. S., Gupta, T. R. & Rao, P. L. N. (1957), J. Indian Inst. Sci., **39A**, 195.

215 Kamat, V. N., DeSa, J., Vaz, A, Fernandes, F. & Bhatnagar, S. S. (1957), Abstr. Symp. on Utilisation of Indian Med. Plants, Lucknow, p. 25.

216 Murthy, P. S. & Sirsi, M. (1957), *Ibid.*, p. 20.

217 Kamat, V. N., Divekar, P. V., Vaz, A., Fernandes, F. & Bhatnagar, S. S. (1957), *Ibid.*, p. 21.

218 Sirsi, M., Natarajan, S., Tirunarayanan, M. O. & Murthy, P. S. (1956), J. Indian Inst. Sci., **37A**, 98.

219 Patel, R. P. & Patel, K. C. (1956), Indian J. Pharm., **18**, 107.

220 *Idem.* (1957), *Ibid.*, **19**, 70.

221 Mukherji, A. & Das, M. S. (1956), Indian Vet. J., **33**, 30.

222 Basu, S. N. & Bose, P. G. (1956), J. Sci. Industr. Res., **15C**, 163.

223 Kurup, P. A. (1956), *Ibid.*, **15C**, 153.

224 Gupta, K. C. & Vishwanathan, R. (1955), Antib. & Chemo., **5**, 22.

225 *Idem.* (1955), *Ibid.*, **5**, 18.

226 *Idem.* (1955), *Ibid.*, **5**, 496.

227 *Idem.* (1956), *Ibid.*, **6**, 194.

228 *Idem.* (1955), *Ibid.*, **5**, 24.

229 Chopra, I. I. & Chopra, C. L. (1957), Abstr. Symp. on Utilisation of Indian Med. Plants, Lucknow, p. 23.

230 Rao, K. R. & Seshadri, T. R. (1955), J. Sci. Industr. Res., **15C**, 189.

231 Popli, S. P. & Vora, V. C. (1955), *Ibid.*, **15C**, 228.

232 Mukherjee, S. L. Naha, J. Raymabargi, S, Laskar, S. L. & Gupta, R. R. (1955), J. Pharm. Pharmacol., **7**, 35.

233 Gupta, S. K., Chakravarthy, R. N. & Mukerji, B. (1956), Arch. Int. Pharmacodyn., **107**, 281.

234 Gupta, S. K. & Chakravarthy, R. N. (1955), Brit. J. Pharmacol. & Chemotherap., **10**, 113.

235 Gupta, S. K. & Mukerji, B. (1956), J. Sci. Industr. Res., **15C**, 53.

236 *Idem.* (1956), *Ibid.*, **15C**, 56.

237 Chatterjee, R. R. & Poddar, R. K. (1956), Nature, Lond. **178**, 799.

238 Jindal, M. N. (1956), J. Indian Med. Ass., **27**, 204.

239 *Idem.* (1955), *Ibid.*, **25**, 52.

240 Grover, R. D. (1957), Indian Med. Forum, **8**, 9.

241 Dutta, B. N., Chakravarthy, R. N. & Chaudhri, R. N. (1955), Bull. Calcutta Sch. Trop. Med., **3**, 29.

242 Misra, B. G., Bami, H. L. & Ray. A. P. (1955), J. Sci. Industr. Res., **14C**, 173.

243 Bami, H. L. (1955), *Ibid.*, **14C**, 231.

244 Ray, A. P., Bami, H. L. & Basu, P. C. (1956), J. Indian Med. Ass., **26**, 217.

245 Dutta, A. G, Basu, V. P. (1955), J. Sci. Industr. Res., **14C**, 61.

246 Kaushiva, B. S. (1955), *Ibid.*, **14C**, 182.

247 Kaushiva, B, S. & Pujari, H. K. (1956), *Ibid.*, **15C**, 160.

248 Kaushiva, B. S. (1956), *Ibid.*, **15C**, 199.

249 Iyer, R. N., Anand, N. & Dhar, M. L. (1956), *Ibid.*, **15C**, 1.

250 Kaushiva, B. S. & Ghatak, S. (1956), *Ibid.*, **15C**, 195.

251 Bannerji, D. (1955), J. Indian Med. Ass,, **25**, 431.

252 Bhaduri, N. V., Chakravarthy, R. N. & Roy, J. (1955), Bull. Calcutta Sch. Trop. Med., **3**, 51,

253 Alfonso, A. & Khorana, M. L. (1956), Indian J. Pharm., **18**, 396.

254 Singh, S. & Singh, M. (1955), Indian J. Med. Res., **43**, 473.

255 Lahiri, S. C. & Guha, A. C. (1956), J. Med. Ass., **27**, 161.

256 Mukerjea, T. D. (1957), Abstr. Symp. on Utilisation on Ind. Med. Plants, Lucknow, p. 48.

257 *Idem.* (1955), J, Sci. Industr. Res., **14C**, 169.

258 Mukerjea, T. D. & Tripathi, R. L. (1956), *Ibid.*, **14C**, 106.

259 Dixit, R. S., Perti, S. L. & Rangnathan, S. K. (1956) *Ibid.*, **15C**, 16,

260 Chopra, I. C., Abrol, B. K. & Nanda, K. L. (1957), Abstr. Symp. on Utilisation of Indian Med. Plants, Lucknow, p. 44.

261 Gujral, M. L., Saxena, P. N. & Mishra, S. S. (1955), J. Indian Med. Ass., **25**, 49.

262 Bannerjee, B., Chakravarti, R. N. & Chaudhuri, R. N. (1957), Bull. Calcutta Sch. Trop. Med., **5**, 71.

263 Bhide, N. K. & Sheth, V. K. (1957), J. Sci. Industr. Res., **16C**, 142.

264 Chaudhury, A. & Sen, P. B. (1955), Ann. Biochem., **12**, 119.

265 Das, P. (1956), J. Indian Med. Ass., **27**, 50.

266 Pillai, N. C., Vidyanathan, C. S. & Giri, K. V. (1956), Proc. Indian Acad. Sci., **43**, 46.

267 Pillai, N. C., Rao, G. J. S. & Sirsi, M, (1957), J. Sci., Industr. Res., **16C**, 106.

268 Sen, S. C. & Sen, S. (1956), Indian J. Med. Res., **44**, 67.

269 Gujral, M. L. & Dhawan, B. N. (1956), *Ibid.*, **44**, 625.

270 Ganatra, R. D., Dhopeshwarkar, G. A., Sheth, V. K. & Lewis, R. A. (1957), Indian J. Med. Sci., **11**, 493.

271 Ojha, K. N. (1955), *Ibid.*, **9**, 534.

272 Gujral, M. L., Kar, P. K. & Saxena, P. N. (1956), J. Postgrad. Med., **2**, 194.

273 *Idem.* (1956), *Ibid.*, **2**, 231.

274 Sirsi, M. & Rao, R. R. (1956), Indian J. Med. Res., **44**, 283.

275 Bhattacharya, B. K. & Lewis, G. P. (1956), Brit. J. Pharmacol., **11**, 202.

CHEMISTRY OF PLANT PRODUCTS

R. N. CHAKRAVARTI & B. DASGUPTA
Department of Chemistry
School of Tropical Medicine, Calcutta

During the year 1957 considerable work was carried out throughout the country on the various aspects of the chemistry of plant products as in previous years.

A symposium on 'Genetics and Plant Breeding in South-east Asia'[1] was held during 21-24 January, 1957 at the Indian Agricultural Research Institute, New Delhi which included papers on uses of plant hormones.

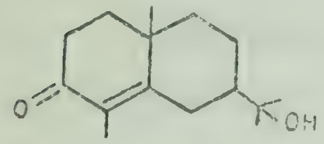
The first annual general meeting[2] of the Essential Oil Association of India was held at Kanauj on 13 February, 1957. At this meeting nine papers were presented on chemical examination, extraction and distillation of essential oils and on cultivation of perfume-bearing grasses. A symposium on 'Chemistry and Technology of Food'[3] dealing with various aspects of the subject was held on 21 September, 1957 under the auspices of the Institution of Chemists (India) at the University College of Science and Technology, Calcutta. Some of the papers presented on the occasion dealt with pulses as sources of protein, various aspects of fat industry, standardisations of tea, asafoetida, etc.

The Pharmaceuticals and Drugs Committee of the Council of Scientific and Industrial Research organised a symposium on the 'Utilisation of Indian Medicinal Plants'[4] at Lucknow on 12-14 October, 1957. The papers were presented under the following heads: Botany and Pharmacognosy, Chemistry, Pharmacology, Pharmaceutics and Therapeutics. Abstracts of the papers have been presented in the form of a useful booklet.

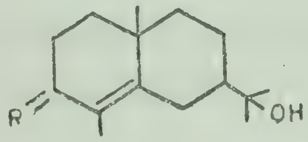
In the following pages an attempt has been made to present an account of the work carried out in the various laboratories in India during 1957 under the following heads: terpenoids including essential oils, steroids, alkaloids, carbohydrates and glycosides, pigments and related products, amino acids, fats, oils and waxes, moulds and lichen products and miscellaneous.

Terpenoids including essential oils

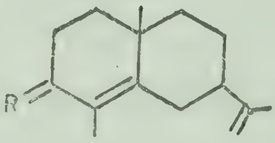
Joshi and Boyce[5] isolated two crystalline compounds, D-glucoside of β-sitosterol and the sequiterpene, carissone, together with a non-crystallisable bitter oil from the roots of *Carissa congesta* (Apocynaceae) which grows on the hills of Western Ghats near Janjira, Bombay. Carissone was previously obtained from *Carissa lanceolata* R. Br. by Reichstein[6] and its structure as (I) suggested by Barton[7] was confirmed by Ayer and Taylor.[8]



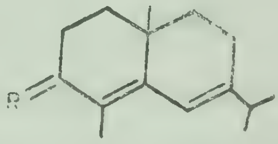
(I)



(II)



(III)



(IV)

$R = :N.NH.C_6H_3(NO_2)_2$.

For isolation of the crystalline carissone, Joshi and Boyce[5] found it convenient to allow the bitter oil, as obtained by alcoholic extraction of the roots, to pass through a short column of neutral alumina and to seed the oil after this treatment. An interesting observation was made regarding the stability of the DNP of carissone (II). When it was run through a column of neutral alumina it was dehydrated to the DNP of α-cyperone (III) which in turn was finally isomerised to the DNP of β-cyperone (IV) by keeping for a long period on a column of alumina. Attempts to induce the oil (left after separation of carissone) to crystallise were unsuccessful even by chromatography.

The bitter oil (containing a small amount of carissone) showed inhibiting activity against the following: *S. paratyphi A*, *Sh. shigae*, *Br. abortus*, *B. proteus* OXK, and *Laterospora*. Carissone when tried against the micro-organisms, showed no inhibition.

A reinvestigation of the galls of *Pistacia integerrima* (Anacardiacae) by Rao and Bose[9] revealed the presence of (a) Pistacienonic acid A, m.p. 175-178° and Pistacienonic acid B, m.p. 158-161° (two triterpene acids), (b) a waxy compound m.p. 75-77°, (c) β-sitosterol and (d) a triterpene alcohol, m.p. 132-133° (acetate, $C_{32}H_{52}O_2$, m.p. 159-160°). The two acids have the same molecular formula $C_{30}H_{46}O_3$ (methyl esters, $C_{31}H_{48}O_3$).

Maiti and Barua[10] isolated a mixture of saponins from the seeds of *Barringtonia acutangula* Gaertn. On acid hydrolysis it gives a mixture of neutral and acid sapogenins. From the neutral fraction two sapogenins, Acutagenol A, $C_{30}H_{50}O_6$, m.p. 249° and Acutagenol B, $C_{30}H_{50}O_5$, m.p. 306-312° have been obtained. The acid sapogenin fraction obtained in extremely poor yield on esterification with diazomethane gave two methyl esters, $C_{32}H_{50}O_6$, m.p. 253-254°, giving no depression in m.p. with an authentic sample of methyl-barringtogenate and methyl acutagenate, $C_{31}H_{50}O_4$, m.p. 301-303°.

The preparation of 4-isopropyl-6-methoxytetralone-1, a potential intermediate in the synthesis of cadinene, is reported by Rao and Deb.[11]

3-Carene isolated from the Indian turpentine oil of *Pinus longifolia* Roxb.* has been found by Verghese, Krishnan and Yeddanapalli[12] to undergo a cleavage of the cyclopropane ring under the catalytic influence of salicylic acid to give rise to the para-derivatives, α-terpinene, terpinolene and *p*-cymene and the *meta*-derivatives, sylvestrene(?) and *m*-cymene. These have been compared with the products obtained by the action of oxalic acid on 3-carene. A carbonium ion mechanism has been proposed to account for the observed products.

Three crystalline substances have been isolated from the leaves of *Rhododendron falconeri* Hook. by Rangaswami and Sambamurthy.[13] These were obtained from the petroleum ether extract in very low yields, and appear to be triterpenoid in nature. From the ether extract ursolic acid was obtained and from the alcoholic extract quercetin.

Krishna and Joshi[14] carried out a modification of the method of Royals[15] for the preparation of β-ionone.

Barua and Maiti[16] resolved the petroleum ether extract of the air-dried powdered bark of *Prunus nepalensis* Koch by chromatography into three distinct fractions. Fraction (a), m.p. 252-256° has been identified with friedelin, $C_{30}H_{50}O$. Fraction (b), m.p. 273-276° has been identified with *epi*friedelinol, $C_{30}H_{52}O$. Fraction (c), m.p. 195-205° was obtained in extremely poor yields. Compounds (a) and (b) appear to be identical with the compounds, m.p. 248-249° and 275-276° obtained previously from the same source by Chakravarti and Momen.[17]

The oil from flowers of *Plumiera acutifolia*, a common garden tree on the West Coast, has been found by Menon and Menon [18] to consist mainly of the primary alcohols geraniol, citronellol, farnesol, and phenylethyl alcohol either free or esterified, together with some linalool.

Fenchone from essential oils has been isolated and estimated by the formation of a crystalline adduct with thiourea by Menon and Menon.[19]

According to Chaudhury *et al.*,[20] peppermint oil obtained from *Mentha piperita* raised in Jammu and Kashmir contains menthyl acetate 20.0%, free menthol 55.8%, menthone 9.1% and hydrocarbons 15.1%. Among the hydrocarbons l-α-pinene, l-limonene, cadinene and some unidentified terpenes were found to be present. They [21] also found that the Dill oil obtained from *Anethum graveolens* raised in Jammu and Kashmir contains carvone 53.0% together with d-limonene, d-α-phellan-drene, terpinene, dillapiole and a waxy product, m.p. 62-63°.

Roy and Chatterjee [22] isolated ursolic acid, a 2-hydroxy-17-carboxy acid of α-amyrin series from the whole plant of *Vtnca rosea* linn.

Lupeol has been isolated from the roots of *Asteracantha longifolia* Nees (Acanthaceae) by Chatterjee and Srimany.[23]

Raman and Barua [24] report the presence of (a) α-amyrin and its acetate, (b) lupeol and its acetate and (c) β-sitosterol in the stem-bark of *Ervatamia coronaria* stapf. (Apocyanaceae).

Lupeol has also been isolated from the roots of *Asteracantha longifolia* and *Strobilanthes auriculatus* by Govindachari *et al.*[25] Hentriacontene has been isolated from the leaves of the former. They [26] also isolated lupeol from the roots, stem and leaves of the plant *Cardanthera uliginosa.*

Chakravarti *et al.*[27] obtained a product from the bark of *Alstonia scholaris* (Dita-bark) which after several crystallisations from alcohol and ether had a constant m.p. 160°. Repeated chromatography of this over alumina, using petroleum ether as eluent, in the last stage using a very long column, yielded two crystalline products, α-amyrin acetate and lupeol acetate.

According to Dutt [28] the leaves and flowering heads of Indian *Cannabis sativa* Linn. or Indian Hashish on distillation with water gives a light essential oil which is different in many respects from the heavy essential oil obtained by conducting the distillation in steam at a moderately high temperature and pressure. Light cannabis oil consists mainly of terpenes amongst which the following have been isolated and identified: *p*-cymene, *p*-cymedene, Myrcene, Dipentene and Caryophyllene. The higher boiling portions of the essential oil consists of unidentified sequiterpenes and sequiterpene alcohols. Heavy cannobis oil consists mainly of unidentified sequiterpenes and sequiterpene alcohols which are apparently the same as in light cannabis oil. Only about one-third of the oil consists of low boiling terpenes, amongst which the following have been isolated and identified: *p*-cymene, *p*-cymedene, Myrcene, Dipentene, $\triangle^2$-carene and caryophyllene.

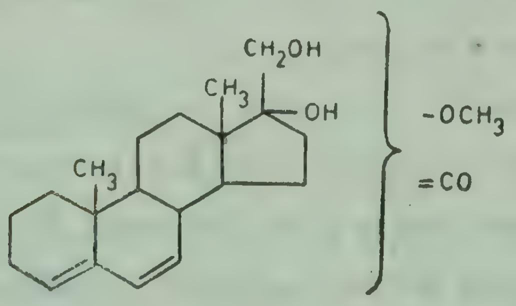
Essential oils are also present in the three narcotic drugs prepared from the leaves and flowering heads of *Cannabis sativa*, e.g., *Bhang*, *Charas* and *Ganja*.

Dutt [29] studied some soap perfumes from the standpoint of three fundamental constituents, *e.g.* (a) the odoriferous principle, (b) the modulator and (c) the fixative.

Zutshi and Sadgopal [30] carried out physico-chemical examination of the essential oil obtained from the roots of *Vetiveria zizanioides* Linn. grown in North and South India.

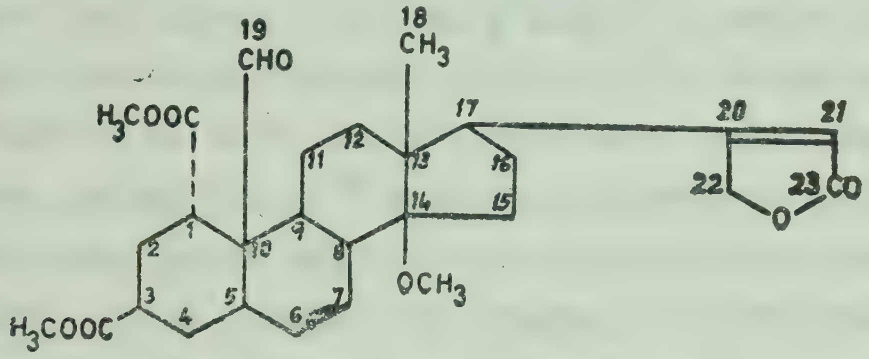
Steroids

A crystalline steroid, $C_{21}H_{30}O_4$, designated as malanthin, has been isolated from the bark of *Ailanthus malabarica* by Rastogi and Dhar.[31] A tentative partial structure (V) has been assigned to malanthin on the basis of its ultraviolet and infrared absorption spectra and other data.



(V)

Nimbin, $C_{28}H_{38}O_3$ the major crystalline bitter constituent of nim (*Melia indica*) was previously characterised by Mitra[32] as a complex steroid belonging to the cardiotonic series. The same author[33] has further studied the constitution of nimbin in detail. From steric consideration and physicochemical data structnre (VI) is provisionally proposed for nimbin.



(VI)

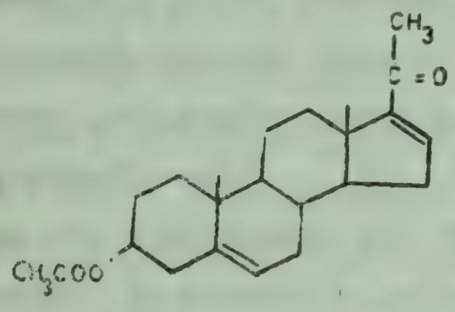
Besides lantadene A (22-β-angeloyloxy-oleanonic acid) and lantadene B (22-ββ-dimethyl-acryloyloxy-oleanonic acid), *Lantana camara* Linn. Var. *aculeata* (bearing brownish orange flowers) gave another crystalline product[34] of a lactonic character, provisionally designated as lancamarone, m. p. 280°. The chemical properties and UV and IR spectra suggest the possibility of its being a ketosteroid with a butenolide grouping, although a triterpenoid structure is not altogether ruled out. It is a fish poison, effective in dilution of 1 in a millon and is cardioactive.

The petroleum ether extracts of the air-dried leaves of L. *salvifolis* yielded a hydrocarbon, m.p. 78°, on chromatography over alumina.

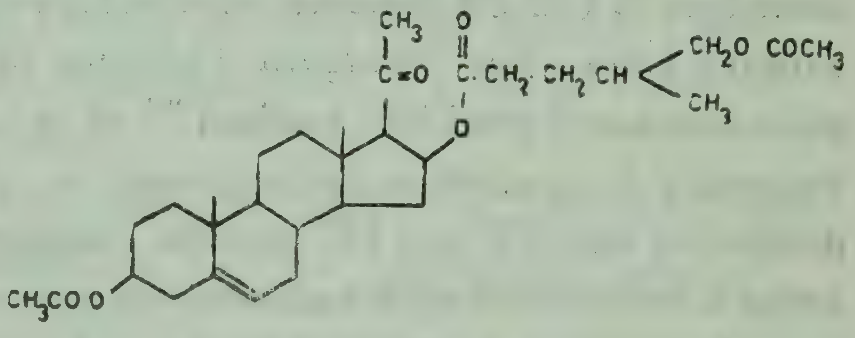
Basu and Rakhit[35] found evidences for presence of alkaloids, reducing sugars, glycosides or polysaccharides, and sterols in the seeds of *Asteracantha longifolia* Nees. Four crystalline substances giving colour reactions for sterols were isolated, (a) asterol I, $C_{28}H_{36}O$, m.p. 183-184°, (b) asterol II, $C_{27}H_{42}O_3$, m.p. 164-165°, (c) asterol III, $C_{30}H_{40}O_3$, m.p. 120-121°, and (d) asterol IV, $C_{23}H_{38}O$, m.p. 190-191°.

Diosgenin was previously obtained in good yields by Chakravarti *et al.*[36-40] from *Dioscorea prazeri* (*Kukur torul*) of Darjeeling and *Dioscrea deltoidea* (*Kins*) of Kashmir. Following up this work, progesterone was prepared[41-43] by the method of Marker *et al.*[44-46] with some modifications. A detailed study was made with regard to the possible variations in the first step which consists in the conversion of diosgenin into pseudodiosgenin. It was found that the optimum temperature for the conversion is 192°. Instead of the previously recommended procedure[44] of heating diosgenin with acetic anhydride in a sealed tube inside a bomb furnace, it was found advantageous to carry out the reaction by taking the mixture in a stout glass tube sealed at one end and closed at the other with a tightly tied cork and heating it to the desired temperature in an erect position in a tall oil-bath.

According to Chakravarti *et al.*[43] a still better method is to heat diosgenin with only one third of the usual amount of acetic anhydride and sufficient amount of triacetin in an ordinary flask under reflux condition, the temperature of the liquid mixture being kept at 192° for the usual period of 10 hours. The yield by this method is quantitative.



(VII)



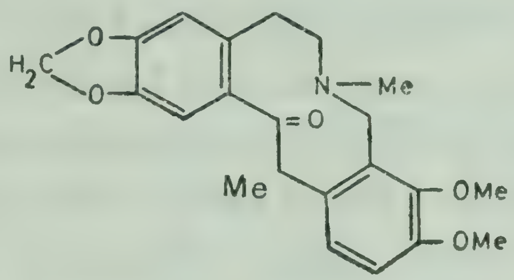
(VIII)

The method of chromatography over alumina was adopted by Chakravarti *et al.*[41] for purification of the chromic acid oxidation product of pseudodiosgenin and as a result $\Delta^{5,16}$-pregnadien-3β-ol-20-one-acetate (VII) was obtained in place of a low melting product (VIII) obtained by Marker *et al.*[45] As in (VII) the side-chain is already knocked off, further hydrolysis according to Marker's procedure is no longer necessary before passing on to the next step. In the remaining two steps for the preparation of progesterone it was found advantageous to carry out the purification by chromatography in place of vacuum sublimation.[44]

A method[47] has been developed for the assay of *Dioscorea deltoidea* and *Dioscorea prazeri* for diosgenin.

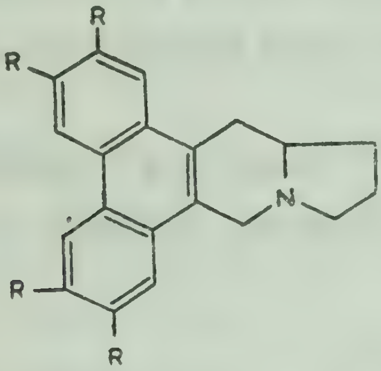
Alkaloids

Govindachari and Rajadurai[48] report the synthesis of the alkaloid, DL-corycavidine (IX) in which *des*-N-methyl-4-methyltetra-hydroberberine is converted into its N-oxide by treatment with perbenzoic acid, followed by hydrolysis of the oxide with acetic acid-hydrochloric acid mixture.



(IX)

In a search for a better spasmolytic drug than papaverine, a series of 3 : 4-dihydro-5 : 6-dimethoxy and 3 : 4-dihydro-5 : 8-dimethoxy isoquinolines have been synthesised by Govindachari and Lakshikantham.[49] These have been dehydrogenated with palladium charcoal to the corresponding isoquinoline derivatives.

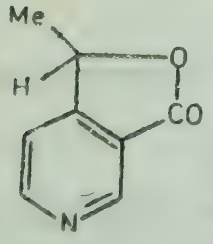


(X); R=OMe

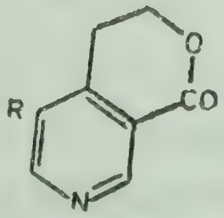
(XI); R=H

On the basis of various degradative results, structure[50] (X) is assigned to tylophorine, $C_{24}H_{27}O_4N$, the major alkaloid of *Tylophora asthmatica.* The parent compound (XI) has been synthesised from phenanthrene-9-aldehyde.

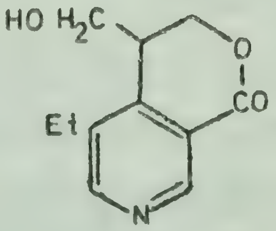
Govindachari *et al.*[51] showed gentianine, an alkaloid, $C_{10}H_9O_2N$, m.p. 82-83°, isolated from *Enicostemma littorale* Bl. (Gentianaceae) to be 4-2′-hydroxyethyl-5-vinyl-nicotinic lactone (XIII) by degradative and synthetic experiments. Structure (XII) was previously assigned to gentianine by the Russian workers Proskurnina *et al.*[52]



(XII) R=CH : CH_2



(XIII) R=CH : CH_2

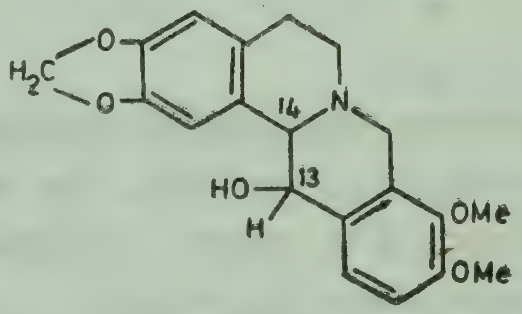


(XIV)

The formation of a dihydro-derivative, ozonolysis of the alkaloid yielding formaldehyde, oxidation with potassium permanganate yielding a lactonic acid, $C_9H_7O_4N$ (presence of a vinyl group), vigorous oxidation yielding pyridine-3 : 4 : 5-tricarboxylic acid, hydrolysis of the lactonic acid followed by decarboxylation yielding a basic oil, oxidation of which yielded iso-nicotinic acid, all these lead to structure (XII) or (XIII) for the alkaloid, but the infra-red evidence (no band in the region 1300-1400 cm^{-1} (C-methyl)) favours the latter, a six-membered lactone. A choice between these structures could be made only by synthesis.

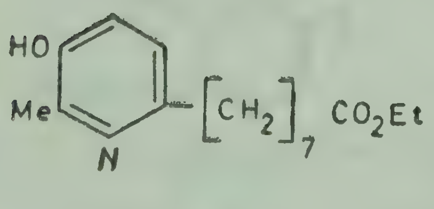
5-Ethyl-4-methylnicotinic acid obtained starting from ethyl α-ethylacetoacetate was treated with formaldehyde yielding the lactone of 2-(3-carboxy-5-ethyl-4-pyridyl) propane-1 : 3-diol (XIV), identical with that obtained from the dihydroderivative of the alkaloid by similar treatment. The action of formaldehyde on the sodium salt of the nicotinic acid yielded the dihydro-derivative of the alkaloid.

Govindachari and Rajadurai[53] report the synthesis of two racemates of the alkaloid, ophiocarpine, isolated and assigned structure (XV) by Manske.[54]

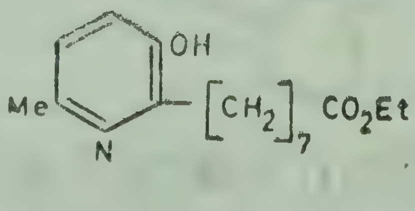


(XV)

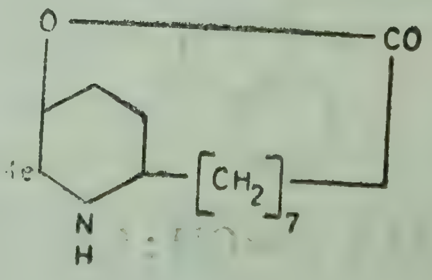
Govindachari and Narasimhan[55] had previously shown that ethyl carpyrinate obtained from the lactonic aldehyde, carpaine, by hydrolysis, esterification, and dehydrogenation could be assigned structure (XVI) or (XVII). A choice now made[56] in favour of (XVI) confirms structure (XVIII) assigned to carpaine by Rapoport *et al.*[57]



(XVI)



(XVII)



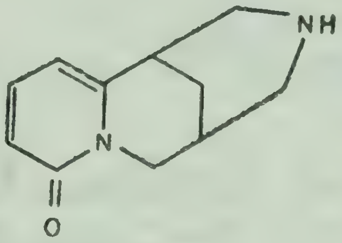
(XVIII)

Govindachari *et al.*[58] report the synthesis of ethyl carpyrinate, (XVI), a degradation product from the alkaloid, carpaine.

The alkaloid, gentianine (XIII) has been synthesised by Govindachari *et al.*[59] by an analogous method for the synthesis of its dihydroderivative.[51]

The syntheses of two protoberberine derivatives, O-methylcapauridine and (±)-tetrahydropalmatine, and a simpler synthesis of (±)-ophiocarpine, the hydroxyberberine alkaloid, are reported,[60]

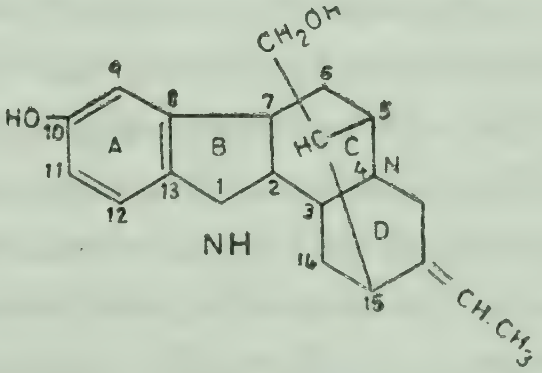
Govindachari *et al.*[61] describe a synthesis of (±)-cytisine (XIX).



(XIX)

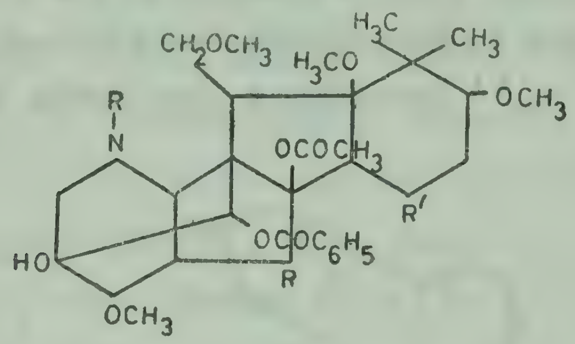
For work on some 1 : 2-benzophenanthridine alkaloids, four new compounds of this group, *i.e.* 7 : 2′ : 3′- and 6 : 2′ : 3′-trimethoxy-, 7-methoxy-2′ : 3′-methylenedioxy-, and 6-methoxy-2′ : 3′-methylenedioxy-9-methyl-1 : 2-benzophenanthridine are reported[62] to be synthesised.

The constitution (XX) of sarpagine, the minor alkaloid of *Rauvolfia micrantha* Hook. and *Rauvolfia beddomei* Hook. f. has been worked out by Talapatra and Chatterjee[63] by various degradative reactions and a study of the UV and IR Spectra.



(XX)

On the basis of a close parallelism in the peripheral groups and degradation products, and close resemblance between the infrared absorption spectra of aconitine and delphinine, obtained from plants of the family *Ranunculaceae*, Nath[64] suggested that the two alkaloids have the same nucleus. Delphinine has been degraded to a hydrocarbon, $C_{17}H_{26}$. Ultraviolet absorption spectrum and chemical properties of the latter indicate it to be a bicyclopentenobenzene. Structures XXI (a) and XXI (b) are tentatively put forward for delphinine and aconitine. On the basis of these it is possible to explain most of the reactions.



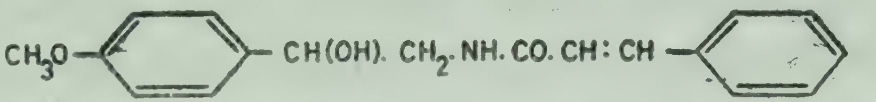
(XXI) (*a*) $R=CH_3$, $R'=H$
(*b*) $R=C_2H_5$, $R'=OH$

Further degradational work on aconitine by Dasgupta and Nath[65] revealed that on oxidation with aluminium *tert*.-butoxide, aconitine yields aconitinone which on heating produces a methoxyl-free compound, aconitoline. The latter has been shown to be an $\alpha\beta$-unsaturated ketone from its UV and IR spectra. An infrared absorption spectrum of pyroaconitine reveals that pyrolysis of aconitine proceeds through the formation of an ethylenic linkage and not an epoxy group. Pyrolytic products obtained at a higher temperature are also described.

Two alkaloids, one water-soluble, *Achyranthine*, $C_6H_{11}NO_2$, H_2O, m.p. 292-293°, and another water insoluble but soluble in chloroform have been isolated by Basu *et al.*[66] from *Achyranthes aspera* Linn. (No. Amarantaceae), and some salts of both the bases have been prepared. The plant contains a large amount of inorganic substances, consisting mostly of potassium chloride.

Basu[67] established the chemical constitution of *Achyranthine* as the betaine derivative of N-methyl pyrrolidine-3-carboxylic acid. Methylation of achyranthine yields N-dimethyl-pyrrolidine-3-carboxylic acid, m.p. 235-238° which is an isomer of stachydrine N-dimethyl pyrrolidine 2-carboxylic acid.

Aegelin, which was previously isolated from the leaves of *Aegle marmelos* correa and reported by Chatterjee and Bose[68] to be a sterol, $C_{18}H_{18}O_4$, was later found to be a neutral nitrogenous product by Chakravarti and Dasgupta [69] and confirmed as (XXII) by degradative reactions as well as its synthesis by condensation of β-hydroxy-β-*p*-methoxy-phenylethylamine with cinnamoylchloride. The above amine has now been prepared [70] by reduction of anisaldehyde cyanhydrin with lithium aluminium hydride. Reduction of aegelone [69] to aegelin with sodium borohydride has also been reported.[70]



(XXII)

Chatterjee and Talapatra [71] isolated 5-methoxyindole from the alkali fusion products of aricine.

Basu and Gode [72] isolated five new alkaloids from the bark of *Alangium lamarckii* Thw. (Alanginaceae). The provisional formulae of the alkaloids are : Base B_1, $C_{19}H_{26}O_2N\ (OCH_3)(OH)_2$, m.p. 197-98°; Base B_2, $C_{17}H_{31}O\ (NCH_3)(OCH_3)_2(OH)_3$, m.p. 119-20°; Base B_3, $C_{16}H_{19}ON\ (OCH_3)(OH_2)$, m.p. 160-61°; Base B_4, $C_{17}H_{19}O_3N\ (OCH_3)_2(OH)_2$, m.p. 149-51° and Base B_5, $C_{19}H_{23}O_4N\ (OCH_3)_2(OH)_2$, m.p. 177-79°. The alkaloids are phenolic bases and contain condensed pyrrole nucleus.

According to Bhandari and Sharma,[73] the thermal degradation of Chaksine iodide is reminiscent of the amide-cyanide transformation.

Rao and Row [74] isolated two alkaloids from the roots of *Tilacora racemosa* Colebr. (N.O. Menispermaceae, a woody climber.) One of them has been found to be identical with tiliacorine, previously isolated by Van Itallie and Steenhauer.[75] A new empirical formula, $C_{36}H_{36}O_6N_2$, $2H_2O$ has been proposed for tiliacorine. A second alkaloid has been isolated from the mother liquors from tiliacorine. The alkaloid gives varying melting points, 163-65° from benzene, and 193° from acetone.

Chatterjee and Roy [76] isolated a new alkaloid, aegelenine $C_{14}H_{10}O_2N_2$ ($-OCH_3$, $-O(CH_2)_2$ and $-N.CH_3$ absent), m.p. 248-50° from the leaves of *Aegle marmelos* Correa (0.0003% yield). Formation of diphenylamine from aegelenine suggests it to be an acridine alkaloid like acromycine.

The two bases isolated from seeds of *Asteracantha longifolïa* Nees by Basu and Rakhit [77] seem to be identical with the water-soluble bases isolated by Basu and Gode [78] from the whole plant. In addition to the two bases isolated in pure form, a very small quantity of chloroform-soluble bases has also been found to be present. The base B ($C_5H_{11}NO_2,H_2O$) which was obtained in greater yield (0.0062 per cent) seems to be some isomer of methyl dihydroxy pyrrolidine. The base A ($C_4H_9NO_3$), obtained in low yield (0.00012 per cent), and base B have been provisionally named as 'asteracanthine' and 'asteracanthinine' respectively.

Bose *et al.*[79] found that the rhizome and the root of *Nardostachys jatamanshi*—Dc. contained 2% of essential oil, 3.5% of resins and 0.016% of alkaloids. The fraction containing the total alkaloids has physiological properties similar to those of *Rauvolfia* alkaloid.

Reserpine has been converted [80] almost quantitatively to 3-epireserpine which has been shown to be responsible for the previously unidentified fluorescent zones in the paper chromatograms of reserpine metabolism products isolated from rats. 3-epireserpine is, however, not a metabolite and has no reserpine-like activity.

The $C_{22}H_{28}N_2O_3$ alkaloid from *Rauvolfia canescens* Linn., provisionally designated as Raunescine is renamed [81] 'Canembine.'

Bose [82] has developed a new method of assay of total alkaloids of *Rauvolfia serpentina*. Four different samples were found to contain 3.48% to 4.20% total alkaloids when assayed by this method, whereas following the B.P.C. method the same samples were found to contain 0.95% to 1.32% total alkaloids.

Using phosphate buffer of different pH and chloroform as the two phases, total alkaloids of *Rauvolfia serpentina* were subjected to fractionation by the countercurrent distribution technique by Chatterjee *et al.*[83] Eight different fractions were obtained of which the last two ($B_{7,8}$) could not be fully separated from each other and was considered as one for the purpose of pharmacological investigation which shows primarily a cholinergic property not only on isolated guinea pig ileum, but also on isolated amphibian and mammalian hearts. The chemical nature of this fraction is yet to be established. From paper chromatographic studies there appears a possibility of the presence of sarpagine in minute traces and of serpine. However, the muscarine like action of $B_{7,8}$ cannot be attributed either to serpine or sarpagine both of which have shown to be non-sensitive to atropine and to possess some degrees of anti-acetylcholine action.

Rauvolfia serpentina roots were pretreated [84] with SDA23A alcohol containing ammonia and then percolated with rectified spirit. The alcoholic percolate is then extracted with petrol ether and the alcoholic layer is treated with 2% hydrochloric acid. This acid extract of the pre-treated percolate is subsequently put to counter-current distribution study for the establishment of fluorescence cum mass curves. This pre-treatment of the alcoholic percolate prior to fractionation proper, helps to remove any contaminant fluorescent non-alkaloidal impurities responsible for anomalous distribution of fluorescence with respect to the alkaloidal mass on counter-current fractionation.

Chatterjee *et al.*[85] carried out pharmacological studies on the action of reserpine and alcoholic extract of total alkaloids of *Rauvolfia serpentina* on blood sugar of anaesthetised cats. The course of events in the total extract group was entirely different from that of reserpine. The consistent finding of lowering of blood sugar after total alcoholic extract of *Rauvolfia serpentina* is particularly important in view of the fact that it is expected to contain reserpine in addition to other alkaloids. There is no correlation with the fall of blood pressure and the ultimate variation in the blood sugar levels.

In view of the fact that the fraction B_1 of total alkaloids of *Rauvolfia serpentina* isolated by countercurrent distribution technique was identified closely with pure ajmaline by paper chromatographic studies, Chatterjee and De [86] carried out some pharmacological observations on the action of ajmaline on isolated guinea pig ileum and its interaction with a few spasmogenic agents.

Ipecacuanha plants cultivated at Rongo, Darjeeling have been found to contain 2.5% alkaloids including 1.4% of emetine.

With the object of evaluating the efficacy of the total alkaloids of ipecac in a suitable form as a drug, the crystalline bismuth iodide complex of the total alkaloids was prepared and tried [87] in gelatine capsules in the treatment of intestinal amoebiasis with promising results.

Chakraborty and Chakraborty [88] attempted to separate the alkaloids from a mixture of six alkaloids *e.g.* berberine, tetrahydropalmatine, tetrahydrojatrorrhizine, tetrahydrocoptisine, neprotine hydrochloride and himanthine by circular chromatography using various solvents. None of the solvents except 10% formamide gave any well defined spots which, however, could not be assigned to a particular constituent due to closeness of R_f values of the constituent alkaloids.

Guha and Das [89] isolated the bound form of nicotinic acid in a crystalline state from rice bran. This bound form of nicotinic acid, from which nicotinic acid is liberated by mild alkali treatment, has been named 'niacinogen'. A colorimetric method of estimation of the bound form of nicotinic acid in presence of free nicotinic acid in rice and wheat has been described.[90] Das and Guha [91] also isolated 'niacinogen' from wheat bran. The fact that the same substance has been isolated from two quite different species of cereals might indicate some common biological role of niacinogen in these plants.

Prasad and Kaul [92] studied the seasonal variation in the alkaloidal content of 'Kurchi' bark, the maximum alkaloidal content being attained soon after the rains (July-September).

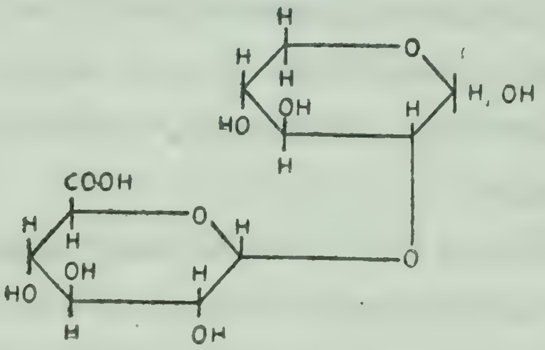
The leaves of *Datura alba* Nees, a wild plant growing in Kashmir, have been found [93] to contain the maximum percentage of alkaloids before the flowering stage, the percentage varying from 0.1 to 0.6 during budding, flowering and fruiting stages. It was also observed that nearly 85 per cent of the alkaloids consisted of hyoscine, the remainder being hyoscyamine, and if the collection is made at the flowering stage the leaves can form a good source of hyoscine.

Handa *et al.*[94] have developed a modified method of assay of *Kurchi.*

The physiological properties of kopsine, an indoline alkaloid isolated[95] from the leaves of *Kopsia albiflora L.* and *K. fructosa*, A. Dc. (Apocyanaceae) and having some similarity in chemical structure to some of the strychnos and picralima alkaloids have been studied[96] and the results have been compared to those of strychnine under identical conditions.

Carbohydrates and glycosides

Murthy and Srinivasan[97] found that groundnut shell helmicellulose A_1 gave on hydrolysis with dilute acid a mixture of an aldobiouronic acid (XXIII), D-xylose and a small quantity of L-arabinose. The acid on vigorous hydrolysis gives D-glucuronic acid and D-xylose.



(XXIII)

The major constituents of groundnut shells are noncellulosic in nature.[98] The hemicellulosic part of the shells has been fractionated into six fractions and their sugar make-up has been determined. Xylose, arabinose and uronic acid are common to all the fractions; these fractions contained, in addition, rhamnose, and two others both rhamnose and galactose.

Groundnut shell hemicellulose A_1 has been shown to contain residues of D-xylose and D-glucuronic acid.[99] The methylated polysaccharide gave on hydrolysis 2, 3, 4, tri-O-methyl-D-xylose, 2, 3-dimthyl-D-xylose and 2-O-(2, 3, 4, tri-O-methyl-D-glucuronosyl)-3-O-methyl-D-xylose in the molar ratio of 1 : 30 : 1. A structure is proposed for the hemicellulose which has a straight chain of ca. thirty 1 : 4-linked β-D-xylo-pyranose residues with D-glucuronic acid existing as a side chain through the C_2 position of one of the xylose residues.

Moudgal *et al.*[100] found arachidoside, the glycoside isolated from groundnut, to be goitrogenic and as a result of the study of phenolic excretion in the urine, it is suggested that the effect is due to preferential iodination of the phenolic metabolites in the thyroid tissue.

Chaudhury *et al.*[101] isolated a pale yellow glycoside, m.p. 118-19° from the seeds of *Ipomea palmata*, commonly known as railway creeper (Hindi-*kaladana*) and mostly used as purgative. It resembles muricatin A in all respects isolated from *Ipomea muricata*. The glycoside on hydrolysis yielded a colourless product, m.p. 104-6°, resembling muricatin B in all its properties. Pharmacological actions of the two products are described.

Raha [102] reports the isolation of D-mannitol from the bulbs of *Allium cepa* (N.O. Liliaceae, onion).

The sugar constituents of the saponin, m.p. 271° isolated from the seeds of *Luffa cylindrica* Roem have been identified by Barua [103] as galactose, arabinose, xylose and rhamnose by paper chromatography.

Shankar and Bharucha[104] made some observations on the acid and sugar changes in the leaves of a non-succulent plant *Amaranthus spinosus* Linn. in sunlight and artificial darkness. The data show that the acid accumulation was accompanied by the inhibition in the rate of loss of sugars which fits in with the scheme that for every molecule of glucose oxidised two molecules of malic acid are formed and therefore the acid synthesis involves little loss of sugars from the tissues. The data on acid and sugar changes during prolonged darkness show that acid is reduced under conditions of prolonged darkness due possibly to the formation of sugars.

Rao[105] discusses the position of tamarind seed jellose amongst carbohydrates *vis-a-vis* the other neutral polysaccharides. On account of its availability in abundance and its cheapness, tamarind seed jellose has a great potentiality of replacing fruit pectins in jam, jelly and marmalade industries.

Gupta *et al.*[106] found yellow roses to be rich in flavonol glycosides. In a large number of cases kaempferol is the predominant component, but in a few cases considerable quantities of quercetin are also present. Red roses also contain appreciable amounts of flavonol mixtures as glycosides. Kaempferol and quercetin are invariable components of both types of roses and myricetin is occasionally present. The presence of flavonol glycosides in considerable quantity may account for the use of rose petals as laxatives. They are also good sources of Vitamin P.

Baruah *et al.*[107] found the principal constituents of the cell wall material of arecanut husk to be pectin, protopectin, hemicellulose, cellulose and lignin, their proportions varying with the maturity of the husk. Experimental trials on the rapid softening of husk and the separation of fibres show that pectinolytic bacteria are more effective than hydrolytic agents like ammonium oxalate and sodium phosphate. Methods have been described for the preparation of hard boards from arecanut husk fibres.

Rangaswami and Rao [108] obtained a number of crystalline and amorphous glycosides from the seed kernel of *Cerbera odollam* Gaertn. on extraction with solvents and fractionation. The principal crystalline glycosides have been identified as cerberin, neriifolin and thevetin from their properties and also by direct comparison with glycosides obtained from *Thevetia neriifolia* Juss.

Macmillan *et al.*[109] critically examined the methods generally employed for the determination of copper number of cellulose and starch in regard to their suitability for the determination of the reducing power of tamarind kernel powder (TKP).

Macmillan *et al.*[110] isolated oligosaccharides by paper chromatography from the incomplete hydrolytic products of jute α-cellulose after a mild treatment with sulphuric acid with the object of elucidating the mode of association of the different sugar components with the glucose unit of the cellulose chain. The individual oligosaccharides, which yielded single spots on being separately chromatographed, were completely hydrolysed with boiling N sulphuric acid and the component sugars chromatographically identified. Glucose has been found to be one of the main components of the oligosaccharides studied. The results seem to offer a direct evidence of the chemical association of glactose, xylose and possibly mannose with the glucose residues of jute α-cellulose. Since it has been noticed that most of the arabinose and rhamnose components are hydrolysed by the action of N/2 sulphuric acid, the chemical linkage, if any, between these two sugars and cellulose, appears to be readily broken.

Mukherjee and Shrivastava [111] studied the nature of sugars and aldobiouronic acid in *Acacia sundra* gum. The presence of rhamnose, arabinose, galactose and xylose was indicated by paper chromatography in the syrup obtained by graded hydrolysis of the gum. The structure of the aldobiouronic acid was established as 6-0-β-D-glucuronopyranosyl-D-galactose.

Sizing trials performed on grey yarn sized with tamarind kernel powder (TKP), defatted TKP, washed TKP and starch indicate[112] that TKP is comparable to starch with respect to increase in tensile strength; only about half the quantity of TKP is required to give the same sizing effect as starch. Defatting is not essential for the use of TKP in sizing, as the oil naturally present in the powder imparts softness to yarn during weaving or knitting. The use of sodium chlorite and ammonium sulphate under suitable conditions completely desizes yarn sized with TKP resulting in simultaneous bleaching.

It has been shown that the formic acid method of Das *et al.* (1955) is superior to the 72% H_2SO_4 method of hydrolysis of jute α-cellulose for detecting its sugar components. By this formic acid method, it has been shown[113] that jute α-cellulose (*C. Capsularis* and *C. Olitorius*) invariably contains appreciable amount of xylose, traces of arabinose and mannose besides glucose. These findings have been found to be true for all recommended methods of jute α-cellulose preparations. These sugars have been confirmed chromatographically from their positions in different solvents and the characteristic colour developed by different spraying agents specific for individual sugars. In view of the above findings it has been suggested that the chemical structure of α-cellulose, which is based on the assumption that its building units are glucose only, needs revision.

In an attempt to shorten the period of incubation of the organism, *Mycobacterium tuberculosis* grown as surface culture on Youman's media for 2-3 weeks, Ramakrishnan *et al.*[114] found that the water of tender coconuts could considerably reduce the number of days required for full growth. The addition of the coconut water, even in a dilution of 1 in 10,000, to the Youman's medium facilitated earlier growth, and the maximum growth normally attained on the Youman's medium by about the twentieth day was found to have been reached in this modified medium by the twelfth day alone. There was no growth on coconut water by itself. The growth-promoting factor was found to be heat-stable. On systematic fractionation of the coconut water to isolate the growth-promoting factor, it was found that of the four fractions, *e.g.* lipids, polysaccharide, amino-acids and the residue, only the polysaccharide fraction showed a growth-promoting effect as a supplement to Youman's medium. The active fraction gave a positive Molish test but no biuret test. It gave no colour with iodine and the test for pectin was negative. The end sugar was not a ketose (negative Seliwanoff reaction) and, on acid hydrolysis, glucose and fructose were detected.

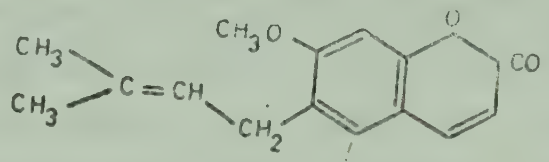
Tamarind leaves were found by Savur[115] to contain two distinct enzymes designated as *Polyose depolymerase*, *P.D.* which reduces the viscosity of polyose solution without cleavage of the glycosidic bonds and *Polyose glycosidase*, *P.G.* which increases the reducing power of polyose solution without appreciable increase in viscosity. The properties of *P. D.* and *P. G.* are characterised.

Subrahmanyan *et al.*[116] demonstrate the presence of considerable quantities of starch in the banana pseudostem. Evidence is presented to show that the starch content of the stems varies and is influenced by the variety, locality, stage of growth, physiological state of the plant and climatic conditions, and particularly by the moisture content of the stems. The desirability of screening varieties with a view to selecting consistent yielders has been emphasised. The process evolved for the manufacture of banana pseudostem starch is outlined, and the potentialities of this new raw material as a source of starch indicated. Physico-chemical properties of the starch have been described. The starch can be used for industrial and edible purposes in place of ordinary starches. Sizing tests have shown that it compares very favourably with the common starches and, in view of the somewhat transparent nature of the pastes, imparts better lustre to the finished goods.

Pigments and related products

Marathe[117] describes a new synthesis of flavonol and 6-methyl-3′, 4′-dimethoxy-flavonol by autoxidation.

The heartwood of *Zanthoxylum rhetsa*, a valuable timber in South India, has been found by Gupta and Seshadri[118] to contain skimmianine, $C_{14}H_{15}O_4N$ and suberosin, $C_{15}H_{16}O_3$ (XXIV). The sapwood contains only very small amount of suberosin and no skimmianine whereas the bark contains neither of the two but it yields a small amount of a neutral solid which gives triterpenoid reactions; the melting points of the acetate (215-16°) and of the benzoate (265-66°) correspond to those of the acetate and the benzoate of lupeol.



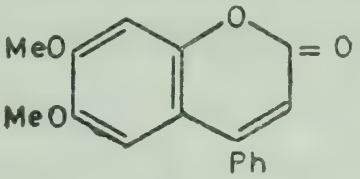
(XXIV)

Cottonseed hulls contain[119] appreciable quantities of leucodelphinidin, not found in the kernels. Damaged seeds sometimes develop a red colour which seems to be due to phlobaphenes derived from the leucoanthocyanidin.

The alcoholic extract of the heartwood of teak (*Tectona grandis*) obtained from Madhya Pradesh, on fractionation, yielded[120] tectoquinone (β-methylanthraquinone) as a neutral product (0.1% yield) which, due to its insect repellent properties, may play some vital role regarding the valuable properties of teakwood. The sapwood yielded a small amount of tectoquinone (0.02%) and glucose in the alcoholic extract. The ether extract of the bark on concentration gave about 1% of a triterpenoid compound, $C_{30}H_{48}O_3$, m.p. 310-15°, identified as betulinic acid, a hydroxy acid, and confirmed by its conversion into betulin using lithium aluminium hydride.

Pavanaram and Row[121] report the isolation of 3-hydroxy-2-methyl anthraquinone besides 2-methylanthraquinone (tectoquinone) from the heartwood of teak. A third colourless neutral compound, m.p. 223-25°, has also been isolated from the petroleum ether and ether extracts.

Ahluwalia and Seshadri[122] have shown by degradative and synthetic evidence, that dalbergin, $C_{15}H_8O_2$ (OMe) (OH), the chief chemical component of the heartwood of *Dalbergia sissoo*, is a monomethyl ether of 4-phenylaesculetin, which is the first natural 4-phenylcoumarin. Oxidation of O-methyldalbergin (XXV) with cold neutral permanganate has yielded benzoic acid, oxalie acid, and 2-hydroxy-4 : 5-dimethoxy benzophenone.



(XXV)

Chibber *et al.*[123] prepared a number of α-methyl-furanoflavones and their dihydro derivatives using 7-hydroxy-8-allyl-flavone derivatives. Ring closure is effected with anhydrous hydrogen bromide followed by pyridine and dehydrogenation with N-bromosuccinimide. 2-Methyl chromone derivatives have also been prepared. Tests with fish of select compounds indicate that dihydrofurano compounds are better poisons and an α-methyl group reduces toxicity in the compounds.

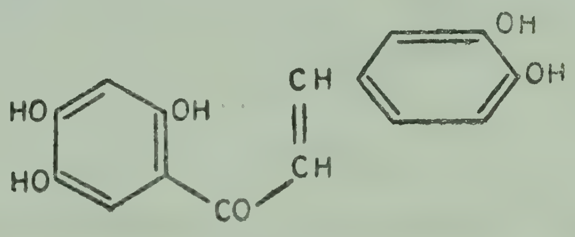
Ganguli *et al.*[124] prepared cyanidin in satisfactory yields from the acetates of (+) catechin and (—) epicatechin by monobromination with N.B.S, and subsequent treatment.

Saxena and Seshadri [125] made a comparative study of hydroxybenzopyrone derivatives with reference to their capacity to form chelate combinations with metals.

Aiyar *et al.*[126] found anhydrous aluminium chloride in ether solution to be a convenient reagent for the selective demethylation of the 5-position of methoxy flavanones and these 5-hydroxy compounds can serve as standard derivatives for comparison. A number of typical compounds are reported, the most important being naringenin dimethyl ether, citronetin monomethyl ether and carthamidin and isocarthamidin trimethyl ethers. The method has been employed for the synthesis of dihydrowogonin which has been recently isolated. This involves the preparation and partial demethylation of 7-hydroxy-5 : 8-dimethoxy flavanone.

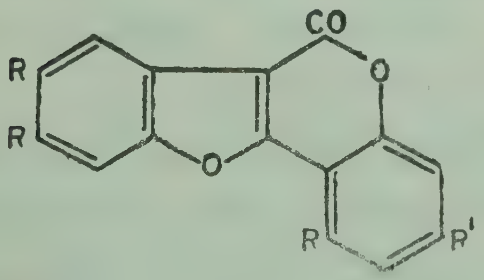
Murti *et al.*[127] prepared 8-methyl baicabin, (1) from 8-methyl chrysin by the preparation of the 6-aldehyde and subsequent Dakin's reaction and (2) from C-methyl-phloracetophenone dimethyl ether by steps involving persulphate oxidation and flavone ring closure. The isomeric 6-methyl compound has been obtained by the nuclear methylation of norwogonin and demethylation with aluminium chloride. The methyl ethers of the former undergo only demethylation when boiled with hydriodic acid whereas those of the latter undergo isomeric change besides demethylation.

On the consideration that stillopsidin (XXVI), the aglycone of the chalkone hexoside stillopsin isolated from the flowers of *Coreopsis stillmanii*, is 5-hydroxybutein, Laumas *et al.*[128] subjected butein trimethyl ether to nuclear oxidation and final methylation to yield stillopsidin tetramethyl ether. Stillopsidin has now been prepared in better yields by an improved method. The product obtained by the partial demethylation of 2 : 4 : 5-trimethoxyacetophenone is shown to be 2 : 5-dihydroxy-4-methoxy-acetophenone which has been prepared by an unequivocal method from paeonol. Similarly an authentic sample of 2 : 5-dihydroxy-4-methoxy benzophenone has been prepared and shown to be the same as that obtained by the partial demethylation of 2 : 4 : 5 trimethoxy benzophenone. A synthesis of 2 : 4-dihydroxy-5-methoxy-acetophenone has also been carried out.



(XXVI)

Govindachari *et al.*[129] showed wedelolactone, isolated from *Wedelia calendulacea* by degradative studies, to be the lactone of 5 : 6-dihydroxy-2-(2 : 6-dihydroxy-4-methoxy phenyl) benzofuran-3-carboxylic acid (XXVII a). Syntheses of the parent ring system (XXVII c) and of tri-0-methyl wedelolactone (XXVII b) are reported.[130]



(XXVII *a*) R = OH, R^1 = OMe

(XXVII *b*) R, R^1 = OMe

(XXVII *c*) R, R^1 = H

Bharucha *et al.*[131] determined the carotene content of a few grasses of Bombay pastures. *Arundinella lawii*, as compared to the other grasses analysed so far, seems to have the highest carotene content (5.0%). With a fall in moisture content of the grasses, there is a tendency for the carotene also to diminish.

Mitra and Roy [132] found that detection of small amounts of turmeric (*Curcuma tinctoria* or *longa*) in other spices was facilitated by making an ether extract of the spice instead of an alcoholic extract and then applying the usual boric acid test to the ether extract. Paper chromatographic separation of the colouring matter of turmeric makes it possible to identify small amounts of turmeric in other spices.

Aminoacids

Nath and Giri [133] determined the optimum conditions for the extraction of proteins from sesame seed meal employing 10% sodium chloride solution. Electrophoretic studies carried out with the seed proteins in the pH range 6.4-8.0 and veronal buffer of ionic strength of 0.1 revealed the presence of one major and three minor protein components. The same authors [134] carried out the fractionation of sesame seed proteins by (1) extraction with different solvents, (2) coagulation by heating at different temperatures, (3) fractional precipitation with ammonium sulphate, (4) dialysis against sodium chloride solutions of different concentrations and (5) dilution and fractional precipitation with ammonium sulphate, and tested the various fractions for their homogeneity electrophoretically. No homogeneous fraction could be isolated by ammonium sulphate fractionation. Dialysis against sodium chloride solutions gave a fraction which was electrophoretically homogeneous but there was considerable loss of protein. The dilution and fractional precipitation method gave the best results and four fractions were isolated. The first, which was the major fraction (65-70%) with an isoelectric point of 4.65, was electrophoretically homogeneous between pH 3.0 and 12.0. This fraction has been identified as the α-globulin described by Jones *et al.*[135] The protein fractions isolated electrophoretically from sesame seed meal have been quantitatively analysed by Nath *et al.*[136] for their amino acid contents by circular paper chromatographic technique. The globulin fractions contain more of the sulphur-bearing amino acids, cystine and methionine and the basic amino acids arginine, histidine and lysine than the whole meal. Serine, proline, glutamic acid and aspartic acid have been estimated for the first time in all the globular fractions and meal.

Globulin isolated from fat-free cashewnut contains 18.9 per cent nitrogen on a moisture (8.7%) and ash-free (0.15%) basis.[137] By paper chromatographic procedure the amino acid composition was found out.

The arginine contents of some oilseed cakes have been studied.[138] Til and groundnut cakes are good sources of arginine.

The trypsin-inhibitor present in double bean (*Faba vulgaris* Moench) has been shown by Apte and Sohonie [139] to markedly affect the rate of tryptic hydrolysis of proteins of skim milk and wheat flour. The release of some amino acids is selectively inhibited; the inhibition gradually decreases with the progress of digestion. The purified inhibitor fed to rats at 0.265 per cent level of the diet does not, however, inhibit their growth.

Notwithstanding the small amount of total nitrogen, palm *gur* has been found by Joshi and Sohonie [140] to contain several essential and non-essential amino acids required for the normal functioning of the body.

Barucha and Joshi [141] found the presence of the following amino acids in the hydrochloric acid hydrolysate of roots and leaves of *Ricinus communis* Linn.; leucine and isoleucine, phenylalanine, valine, methionine, tyrosine, proline, alanine, glutamic acid, threonine, glycine, serine, aspartic acid, arginine, histidine, lysine and cystine. Besides these, a band or spot corresponding to α-aminobutyric acid was seen in the acid hydrolysates of young and old leaves. Total nitrogen percentage by dry weight in different parts was also determined.

Esh and Som [142] studied the influence of pulse proteins on the promotion of xanthine oxidase activity in the liver by feeding them to rats at different stages of growth and maintenance with and without supplementation of methionine.

Fats, Oils and Waxes

The iodine value and Butyrorefractometer reading of sesame oil-arachis oil mixtures containing upto 20% of arachis oil fall within the range prescribed for sesame oil under the Prevention of Food Adulteration Act. But the turbidity temperature of sesame oil is significantly altered by admixture with even 5% of arachis oil. A figure of over 21.0 not only definitely proves adulteration, but also enables the calculation of the percentage of arachis oil present. Hence Sarma and Balasubrahmanyan[143] suggest that the turbidity temperature of 19.0 to 21.0 be also included in the rules as an additional standard.

Osmani and Naidu[144] found that the alcohol soluble portion derived from Karanja oil (*Pongamia glabra*) appeared to contain practically all the toxic material. The potency of Karanja oil and its concentrate appear to be of the same order as that of *Annona squamosa* and rotenone although of a delayed type.

Sarkar and Chakravarti[145] found that both *Bischofia javanica* Blume and *Antidesma diandrum* Roth seed fats are rich in polyethenoid acids, the combined percentage of linolenic and linoleic being 60 and 63 in both these cases. The latter is distinguished by the presence of a comparatively high percentage of saturated acids, unusual in this family. The preliminary results indicate that *B. javanica* seed fat has high potentialities with regard to its use as a raw material in the surface coating industries.

Chakravarti and Palit[146] studied the course of decomposition of a magnesium salt of oleic acid under the usual conditions of decarboxylation.

Sengupta and Chakravarti[147] found that the oil from seeds of *Citrullus colocynthis* of Indian origin could be used as linoleic rich drying oil, as it contains 59.20% linoleic acid besides other acids.

Chaudhury *et al.*[148] found calamus root oil from Kashmir to contain palmitic acid and its ester, heptylic acid, isoeugenol, butyric ester, α-pinene, camphor, calamene, hydrocarbons, calamenone, calamol, azulene and asarone, whereas that from Jammu Province contains palmitic and butyric esters, eugenol and isoeugenol, asarone, hydrocarbon, calamol and azulene. Chenopodium oil from plants *Chenodium ambrosioides* var. *anthelminticum* grown in Jammu and Kashmir has been found [149] to contain mainly ascaridole and *p*-cymene; safrole and limonene are present in very small quantity.

Narang and Puntambekar [150] studied the chemical composition of the mixed fatty acids of the five Lauraceae fats by the modified method consisting of crystallisation of trilaurin of the fats from alcohol and separation and identification of the individual fatty acids in the alcohol soluble portion of the fats in the usual manner. The glyceride composition of the fats has been estimated by employing the two methods of Kartha. The fat from the seeds of *Cinnamomum camphora* Nees (No. Lauraceae) has been found [151] to contain the glycerides of lauric, capric and oleic acids together with a small quantity of unsaponifiable matter.

On a reinvestigation Ganguly and Bhattacharyya [152] found the non-saponifiable portion of the oil of *Pisum sativum* Linn. to yield on chromatography oily and waxy hydrocarbons of unknown constitution together with β-amyrin and β-sitosterol.

Anthraquinone-1 and 2-sulphonic acids and other acids and esters and phenol-substituted sulphonic acids have been studied with respect to their catalytic action in the dehydration of castor oil.[153,154]

Linoleic acid in fatty acid mixtures can be determined on the basis of the tetrabromide value. In the presence of linoleic acid, the ether insoluble hexabromostearic acid has to be removed from the brominated fatty acids prior to the separation of tetrabromides.[155]

The stabilities of hydrogenated fats can be correlated with the extent and nature of the fatty acids present.[156]

The seeds of *Sisybrium loselii*, an annual wild herb in Kashmir, contain a green oil (29.5%) containing palmitic (1.03%), stearic (2.61%), arachidic (0.97%), oleic (27.27%), linoleic (45.75%), linolenic (14.55%) acids and β-sitosterol in the unsaponifiable fraction.[157]

Aca-catechin, a constituent of catechu (*katha*) has been found promising in its use as an antioxidant for fats, oils, etc.[158]

Calophyllolide, a lactone, calophyllic acid, a new **polyene** acid, inophyllic acid, and an essential oil fraction have been isolated from the non-glyceridic portion of the oil obtained from the nuts of *Calophyllum inophyllum* Linn.[159]

Catalytic isomerisation of dehydrated castor oil using aluminium iodide (1%) with a depolymerizer (0.25%, $Zncl_2$) has been carried out, and the isomerized oil on treating with quicklime yields a light colored product of low viscosity and acid value, having 50% conjugated isomers.[160]

Benzene-extracted kamala seed oil on alcoholysis yields modified oil having gelation properties similar to those of tung oil. The gelling quality is improved by addition of other drying oils, antioxidants or stabilizers.[161]

Bhargava *et al.*[162] studied the physical and chemical properties of the oil obtained from the seeds and shell of the plant, *Xanthium strumarium* (*chota-gokhara*).

The stability of vanaspati made up of a mixture of hydrogenated groundnut oil and hydrogenated red palm, linseed or mustard oils or varying proportions has been investigated and compared with that of hydrogenated groundnut oil under different storage conditions.[163] The stability of vitamin A acetate in vanaspati enriched with vanitin used under different conditions of storage and cooking has been studied.[164]

A porous hard polymer obtained from commercial cashewnut shell liquid on condensation with formaldehyde is sulphonated with sulphuric acid to produce a cation-exchange resin. This resin (CNSL) has been studied and compared with resin (C_2) prepared from cashewnut shell liquid, sulphuric acid and chlorosulphonic acid.[165]

The drying properties of *Argemone mexicana* seed oil in admixture with linseed oil with cobalt linoleate have been studied.[166]

Segregation characteristics of the conjugated mixed fatty acids of the seed oils, viz. garden balsam (*Impatiens balsamina*), tung (*Aleurites montana*) and dehydrated castor oil have been investigated by the application of urea-adduct technique.[167]

Gupta *el al.*[168] examined chemically the component fatty acids from the seed fat of *Caesalpiniae digyna*. (Leguminoseae) by ultraviolet absorption and low-temperature crystallisation techniques as also by other usual methods.

Chakrabarty *et al.*[169] found that mercuric chloride catalyst accelerates the speed of addition of thiocyanogen to unsaturated oils, and at the same time retards polymerisation of the reagent.

Chakrabarty and Chakrabarty [170] examined the extent of variation in the composition of various samples of tobacco seed oils of Indian origin with respect to environmental changes.

Glycerolysis of groundnut oil has been effected with $K_2 CO_3$ as a catalyst.[171]

Effects of several adsorbents on the peroxide values of oils have been studied and also some of the factors influencing removal of peroxide in rancid fats.[172]

The effect of conjugated trienoic acid glycerides on the formation of wrinkles in varnish films has been studied.[173]

The refined oil from seeds of *Argemone mexicana* has possibilities of industrial use in hydrogenation, soap making and also as a semi-drying oil.[174]

The seed fat of *Pongamia glabra* contains about 40% of oil, and the contents of various component fatty acids have been estimated.[175]

Three samples of kamala seed oil were investigated and the results obtained differ appreciably from the earlier reports.[176]

The seeds of *Vigna catjang* are very poor in oil content, and the composition of the seed fat places it in the rank of other common oils.[177]

Monoglycerides from coconut, groundnut and castor oils were prepared and tested for their surface active properties, the first possessing good wetting power.[178] Surface active properties of the monoglyceride sulfates of polang and neem oil have been studied. [179]

Studies on the seed fat composition of *Gynandropsis pentaphylla* were carried out, and the seed oil appears to be suitable for edible fat and soap industries.[180]

Oleic-rich seed fats of soapnut, papaya, nux vomica, sweet almond and guava have been analysed for component fatty acids by ester fractionation. Possible uses are suggested.[181] Linoleic-rich seed fats of sweet orange, coffee (arabica and robusta varieties) and teak have also been analysed for component fatty acids by ester fractionation.[182]

Banerjee[183] describes the process of manufacture of Igepon-I, a synthetic detergent, from oleic acid, a bye-product of stearic acid industry.

Phenylhydrazine derivatives of some fatty acids have been prepared by boiling in phenylhydrazine for 20 mins. and precipitation with petroleum ether.[184]

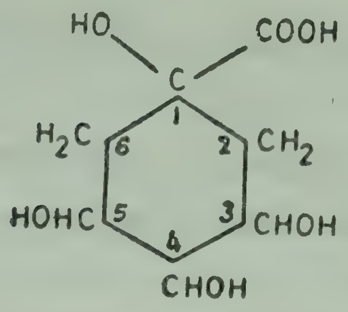
The composition of the *Citrus aurantium* seed fat has been found. The oil is not bitter and can be used for medicinal and edible purposes.[185]

Biswas[186] arranges the different inedible oils in order of superiority of surface active properties as follows, from a study of the surface active properties of their monoglyceride sulfates : Neem, Polang, Karanja, Nahor.

Moulds and lichen products

The similarity between the two groups of compounds most commonly found in fungal metabolites and in lichens and named polyporic acid derivatives and pulvinic acid derivatives, is shown by the following : (1) formation of similar degradation products from both of them, (2) ready conversion of a terphenyl quinone, *e.g.*, polyporic acid into a dilactone, *e.g.* pulvinic dilactone. Mittal and Seshadri[187] consider that both the groups may be derived from the same precursor, *viz.*, two units of β-phenyl glyceric aldehyde and suggest a scheme for the biosynthesis of the two types.

Chatterjee *et al.*[188] have isolated an acid, cordycepic acid, $C_7H_{12}O_6$ in 7% yield from the fungus *Cordyceps sinensis* (Berkeley) Saccards, which grows out as a parasite from the anterior part of the caterpillar of a Lepidopteran moth. Its structure has been determined as 1, 3, 4, 5-tetrahydroxy-cyclohexanoic acid (XXVIII), isomeric with quinic acid, and differing from it in being dextro-rotatory and not forming the lactone.



(XXVIII)

Ghosh and Guha Thakurta[189] have economically produced phenoxymethyl penicillin in this country by using mustard and sesame oil cakes, together with phenoxy acetic acid as precursor, as a constituent of the fermenting medium instead of the costly yeast autolysate. The highest yield was 2500 unit per ml. of media.

Vora *et al.*[190] isolated an antibiotic (X 340) active against a large variety of micro-organisms from an unidentified *Streptomyces* species. On the basis of chemical data a partial structure of the compound is suggested.

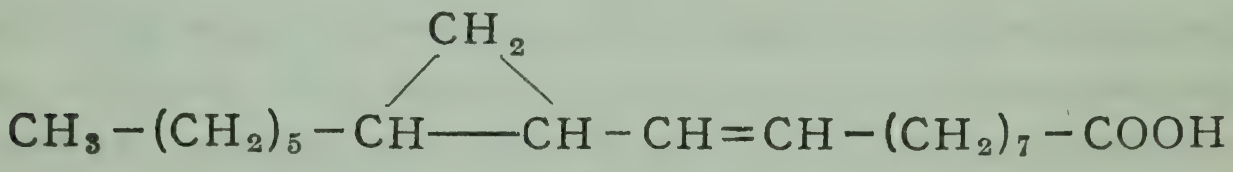
The *in vivo* production of fusaric acid, a toxin/antibiotic produced by *Fusarium vasinfectum* AtK, has been studied at varying temperatures.[191]

Strains of *Penicillium chrysogenum* and *Aspergillus oryzae* grown in a complex and in a synthetic medium, were analysed chromatographically for their amino acid composition. The percentage of nitrogen in the two fungi has been found and compared.[192]

Miscellaneous

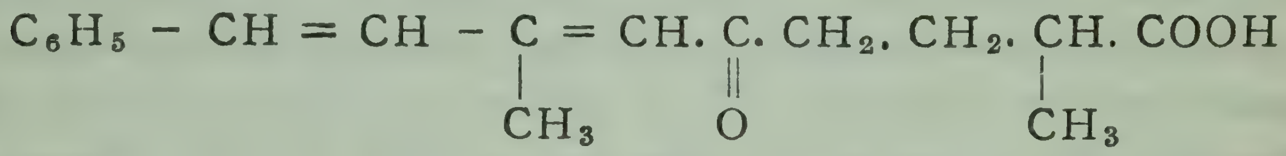
Several indigenous drugs, *Pterocarpus marsupium*, *Engenia jambolana*, etc. were tried for their antidiabetic properties.[193] A few natural glycosides and compounds related to isothiocyanates were studied to obtain an insight into the structural relationship and their antibacterial activities.[194,195] Reductones occurring in stored food products react like ascorbic acid which can, therefore, be estimated correctly by the titration procedure rather than the colorimetric method.[196] A method for spectrographic analysis of microelements in citrus leaf has been worked out.[197] A crystalline substance, vakerine, $C_{15}H_{18}O_{10}$, and an amorphous sterolglycoside have been isolated from the root of *Wagatea spicata* Dalzell. Vakerine contains an enolysable ketone group and four hydroxyl groups.[198] Jute fibres, cotton and silk have been bleached by free radicals by immersing in potassium permanganate solution and then in oxalic acid solution.[199] Common forms of adulteration of tea can be detected by extracting it with ethyl acetate.[200] Isolation of three crystalline substances from the seeds of *Cassia tora* Linn. is described.[201] The dealcoholized extracts of *Cassia tora* seeds and *Cassia obovata* leaves are found to have antibacterial action and compared with penicillin and dihydrostreptomycin.[202] A liquid extract prepared from the whole drug of *Asteracantha longifolia* Nees. is found to have diuretic property.[203] Three components have been isolated from the fruits ot *Luffa echinata* Roxb., (a) an oil, (b) echinatin, $C_{18}H_{26}O_5$ m.p. 174° and (c) a saponin.[204] Aqueous and dealcoholized extracts of colocynth fruits were found to be effective against gram-positive and gram-negative organisms.[205] A preliminary chemical study of *Nardostachys jatamansi* De has been carried out.[206] Pharmacological studies of *N. jatamansi* reveal the sedative and depressent effect of the drug which is also endowed with a marked hypotensive property making it closely similar to *Rauvolfia serpentina.*[207] Aqueous and dealcoholized extracts of the herb *Enicostema littorale* have been found to have antibacterial activity. The active principle is stable to autoclaving.[208] The pharmacological study of infected Bajri (*Pennisetum typhoideum*) grains shows the presence of ergot alkaloids.[209] Chemical and physical investigations of swietenine, $C_{18}H_{24}O_5$, the non-bitter lactonic principle of *Swietenia macrophylla* King, indicate a hydronaphthalene lactone structure for swietenine.[210]

The fruits of *Aegle marmelos* Correa contain allo-imperatorin and β-sitosterol, besides imperatorin, a $\gamma\gamma$-dimethylallyl-oxyfuro-coumarin.[211] A method for the determination of polyphenolic constituents of Indian coffee has been found out and the effects of roasting and storage on them have been studied.[212] A considerable degree of rot resistance is imparted to jute materials by dipping them in a bath of a soluble copper salt.[213] A method for the preparation of a riboflavin concentrate by *Eremothecium ashbyii* employing wheat and rice brans as substrate has been described.[214] Factors possessing vitamin B_{12} like activity present in palm *gur* have been characterised employing several test organisms.[215] A yellow solid material isolated from onion possesses antioxidant activity.[216] Sterculic acid, present to the extent of 70% in the fatty acids of the seed kernel oil of *Sterculia foetida* Linn. has been assigned the structure (XXIX) on the basis of various chemical reactions.[217]



(XXIX)

Inophyllic acid, $C_{17}H_{20}O_3$, isolated from the non-glyceridic portion of the nut oil of *Calophyllum inophyllum* has been assigned the following structure (XXX).[218]



$$C_6H_5-CH=CH-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH.\underset{\displaystyle O}{\underset{\|}{C}}.CH_2.CH_2.\underset{\displaystyle CH_3}{\underset{|}{CH}}.COOH$$

(XXX)

Various proofing treatments previously found to confer rot-resistance to jute fabrics have been tested for efficiency against weathering damage.[219] Several indigenous plants have been tested for their blood anticoagulant activity.[220] Banana in the diet improves the liver store of thiamine.[221] Free and alkaline extracts prepared from tamarind seed testa were used for preparing adhesives.[222] *Henna* leaves have been successfully and economically used in textile industry.[223] Raw jack (*Artocarpus integrifolia*) seed contains a powerful trypsin inhibitor which can be extracted with phosphate buffer or dilute hydrochloric acid.[224] A photometric method for the determination of organic sulphur in asafoetida has been described.[225] Detailed chemical examination has been carried out to find the structure of vakerine, $C_{14}H_{16}O_9$, the polyhydroxy crystalline compound isolated from *Caesalpina digyna.*[226] Polyethylene film of 300 gauge has been found to be the most suitable material for packaging walnut kernels under different conditions of temperature and relative humidity.[227] Garlic, amongst other spices, is the most potent spice, exhibiting high antibacterial action on several organisms.[228] The possibility of the use of three chemicals, *e.g.* coumarin, aesculin and salicin, in chromosome analysis is discussed.[229] Charcoal obtained by the low temperature carbonisation of jute-sticks activated with zinc chloride is quite suitable for being used as medicinal charcoal.[230] A chromatographic method of detection of griseofulvin in guttation drops of rice seedlings (*Oryza sativa L.*) has been described.[231] A dealcoholized, detannated extract of the herb, *Onosma bracteatum* Wall., lowers the blood pressure, depresses the heart and causes vasoconstriction. The drug appears to be useful as a spasmolytic.[232] The enzyme 'flavokinase' occurs in 13 plants (grams, beans, peas, etc.). The method of preparation of the enzyme is described which was chromatographically shown to be identical with flavin mononucleotide.[233] Using resting, as well as germinating, seeds of *Phaseolus radiatus* (green gram), preliminary experiments were carried out to assess the role of 4-amino 5-imidazole carboxamide as a potential precursor of purines in plants.[234] Some functional groups in nimbin, the bitter constituent of *Melia azadirachta* Linn., were detected by chemical and spectral studies.[235] *Rauvolfia serpentina* does not seem to modify the usual effects of ACTH and hydrocortisone.[236] Comparative studies of activated carbon prepared from groundnut hull and teakwood sawdust have been made.[237] The antitubercular activity of a number of plant materials have been studied.[238] An aqueous extract from the seeds of *Dolichos biflorus* Linn. appears to possess diuretic action.[239] Grains (wheat) of *Triticum durum* and *T. vulgare* grown under dry and irrigated conditions have been examined to find out their constituents.[240] The effect of blanching, autoclaving and storage on the ascorbic acid, thiamin, riboflavin and niacin contents of green peas has been reported.[241] A study of the indophenol-reducing substances in palm *gur* indicated the presence of l-ascorbic acid and reductone.[242] The determination of the bound and the total nicotinic acid of different varieties of rice samples was undertaken following treatments.[243] Dehydroascorbic acid reductase from *neera* (juice obtained by tapping date palm tree), when purified, exhibited a maximum activity at pH 6.8 and 40°C beyond which the enzyme was rapidly inactivated.[244] Some natural coumarins, psoralen, seselin, luvangetin and xanthyletin, have been found to show pronounced antifungal properties against *Curvularia lunata.*[245] m-Xylohydroquinone, an active principle of *Pisum sativum* Linn., fails to inhibit the action of progesterone on the uterus.[246] Drum-dried banana powder has been chemically analysed and its inclusion in synthetic or rice-diets is discussed.[247]

REFERENCES

1 'Symposium on Genetics and Plant Breeding' (1957), J. Sci. Industr. Res., **16A**, 107.

2 'Essential oil Association of India—A meeting' (1957), *Ibid.*. **16A**, 311.

3 'Symposium on Chemistry and Technology of Food' (1958), J. & Proc. Inst. Chemists, **30**, 3.

4 'Symposium on the utilization of Indian Medical Plants—Abstracts of Papers' (1957), Lucknow, Oct. 12—14.

5 Joshi, D. V. and Boyce, S. F. (1957), J. Org. Chem., **22**, 95.

6 Reichstein, T. (1954), Helv. Chim. Acta, **37**, 462.

7 Barton, D. H. R. (1954), J. Chem. Soc., 3492.

8 Ayer, W. A. and Taylor, W. I. (1955), *Ibid.*, 3027.

9 Rao, K. V. and Bose, P. K. (1957), Sci. & Cult., **22**, 515.

10 Maiti, P. C. and Barua, A. K. (1957), *Ibid.*, **22**, 516.

11 Rao, G. S. K. and Deb, Sukh. (1957), J. Indian Chem. Soc., **34**, 255.

12 Verghese, J., Krishnan, T, S. S. and Yeddanapalli, L. M. (1957), J. Sci, Industr. Res., **16B**, 363.

13 Rangaswami, S. and Sambamurthy, K. (1957), Proc. Ind. Acad. Sci., **46A**, 245.

14 Krishna, H. J. V. and Joshi, B. N. (1957), J. Org. Chem., **22**, 224,

15 Royals, E. E. (1946), Ind. Eng. Chem., **38**, 546.

16 Barua, A. K. and Maiti, P. C. (1957), Sci, & Cult., **23**, 155.

17 Chakravarti, D. and Momen, S. A. (1950), *Ibid*,, **15**, 329.

18 Menon, T. M. and Menon, T. C. K. (1957), Curr. Sci,, **26**, 89.

19 *Idem* (1957), *Ibid.*, **26**, 123.

20 Chaudhary, S. S., Singh, Het and Handa, K. L. (1957), Ind. J. Pharm., **19**, 74.

21 *Idem* (1957), *Ibid.*, **19**, 76.

22 Roy, S. and Chatterjee, A. (1957), J. Indian Chem. Soc,, **34**, 340.

23 Chatterjee, A. and Srimany, S. K. (1957), *Ibid.*, **34**, 882.

24 Raman, S. P. and Barua, A. K. (1957), *Ibid.*, **34**, 912.

25 Govindachari, T. R., Nagarajan, K. and Pai, B. R. (1957), J. Sci. Industr. Res., **16B**, 72.

26 Govindachari, T. R. and Nagarajan, K. (1957), *Ibid.*, **16B**, 511.

27 Chakravarti, (Mrs.) D., Chakravarti, R. N. and Ghosh (Miss), R. (1957), Exper., **13**, 277.

28 Dutt, S. (1957), Indian Soap J., **22**, 242.

29 *Idem* (1957), *Ibid.*, **23**, 3.

30 Zutshi, N. L. and Sadgopal (1957), *Ibid.*, **23**, 43

31 Rastogi, R.P. and Dhar, M. L. (1957), J. Sci. Industr. Res., **16B**, 74

32 Mitra, C. (1956). J. Sci. Industr. Res., **15B**, 425.

33 *Idem* (1957), *Ibid.*, **16B**, 477.

34 Nigam, S. K., Sharma, V. N. and Kaul, K. N. (1957), *Ibid.*, **16B**, 514.

35 Basu, N. K. and Rakhit, S. (1957), Indian J. Pharm., **19**, 282.

36 Chakravarti, R. N. (1952), Proc. Symposium on "The recent progress in Hormone Research and the use of Hormones in Therapeutics," Feb. 15-165.

37 *Idem* (1955), Bull. Cal. School Trop. Med., **3**, 60.

38 Barua, A. K., Chakravarti (Mrs.) D. and Chakravarti, R. N. (1953), Indian Med. Gaz., **88**, 422.

39 *Idem* (1954), J. Indian Chem. Soc., **31**, 173.

40 *Idem* (1956), *Ibid.*, **33**, 799.

41 Chakravarti, R. N., Chakravarti, Debi and Mitra, M. N. (1957) Bull. Cal. School Trop. Med., **5**, 1.

42 Chakravarti, R, N., Mitra, M. N. and Chakravarti, Debi (1957), *Ibid.*, **5**, 67.

43 Chakravarti, D. Chakravarti, R. N. and Mitra, M. N. (1957), Nature, **179**, 1188.

44 Marker, R, E., Tsukamoto, T. and Turner, D. L. (1940), J, Amer, Chem. Soc., **62**, 2525.

45 Marker, R. E., Turner, D. L., Wagner, R. B., Ulshafer, P. R., Crooks, H. M. and Wittle, E. L. (1941), *Ibid.*, **63**, 774.

46 Marker, R. E. and Turner, D. L. (1940), *Ibid.*, **62**, 3003.

47 Chakravarti, R. N. and Dash, S. (1956), Bull. Cal. School Trop. Med., **5**, 174.

48 Govindachari, T. R, and Rajadurai, S, (1957), J. Sci. Industr. Res., **16B**, 506.

49 Govindachari, T. R. and Lakshikantham, (Miss) M. V. (1957), Proc. Indian Acad. Sci., **46A**, 406.

50 Govindachari, T, R., Lakshikantham, (Miss) M. V., Nagarajan, K. and Pai, B. R. (1957), Chem. & Industry, 1484.

51 Govindachari, T, R., Nagarajan, K. and Rajappa, S. (1957), J. Chem. Soc., 551,

52 Proskurnina, N. F., Shpanov, V. V. and Konovalova, R, A. (1944), J. Gen. Chem. (U.S.S.R.), **14**, 1148, Chem. Abs., 1946, **40**, 7213, Doklady Akad. Nauk U.S.S.R., 1949, **66**, 437 ; Chem., Abs., 1950, **44**, 159.

53 Govindachari, T. R. and Rajadurai, S. (1957), J. Chem. Soc., 557.

54 Manske, R. H. F. (1939), Canad. J. Res., **17**, B, 51.

55 Govindachari, T. R. and Narasimhan, N. S. (1953), J. Chem. Soc., 2635.

56 Govindachari, T. R. Narasimhan, N. S. and Rajadurai, S., (1957), J. Chem. Soc., 558.

57 Rapoport, H. Baldridge, Jr., H. D. and Volcheck, Jr., E. J. (1953), J., Amer. Chem. Soc., **75**, 5290.

58 Govindachan, T. R., Narsimhan, N. S, and Rajadurai, S. (1957), Cham. Soc., 560,

59 Govindachari, T. R.. Nagarajan, K. and Rajappa, S. (1957), *Ibid.*, 2725.

60 Govindachari, T. R., Rajadurai, S., Subramanian, M. and Viswanathan, N. (1957), *Ibid.*, 2943.

61 Govindachari, T. R., Rajadurai, S., Subramanian, M, and Thyagarajan, B. S. (1957), *Ibid.*, 3839.

62 Gopinath, K. W., Govindachari, T. R. Nagarajan, K. and Viswanathan, N. (1957), *Ibid.*, 4760.

63 Talapatra, S. K. and Chatterjee, A. (1957), Sci. & Culture, **22**, 692,

64 Nath, B. (1957), J. Sci. Industr. Res., **16B**, 159.

65 Das Gupta, S. and Nath, B. (1957), J. Indian Chem. Soc., **34**, 204.

66 Basu, N. K., Singh, H. K. and Aggarwal, O. P. (1957), J. & Proc. Inst. Chem., **29** 55.

67 Basu, N.K. (1947), *Ibid.*, **29**, 73.

68 Chatterjee, A, and Bose, S. (1952) *Ibid.*, **29**, 425.

69 Chakravarti, R. N, and Dasgupta, B. (1955), Chem. & Ind., 1632.

70 Chatterjee, A. and Chaudhuri, N, A. (1957). Sci. & Culture, **23**, 155.

71 Chatterjee, A. and Talapatra, S. K, (1957), Sci, & Culture, **23**, 206.

72 Basu, N. K. and Gode, K. D. (1957), J. Indian Chem. Soc., **34**. 629.

73 Bhandari, P. R. and Sharma, V. N. (1957), J. Sci. Industr. Res., **16B**, 97.

74 Rao, K. V. J. and Row, R. (1957), *Ibid.*, **16B**, 156.

75 Van Itallie, T. B. and Steenhauer, A. J. (1922), Pharm. Weekbl., **59**, 922.

76 Chatterjee, A. and Roy, S. K. (1957), Sci. & Culture, **23**, 106.

77 Basu, N. K. and Rakhit, S. (1957), Indian J. Pharm., **19**, 285.

78 Basu, N. K. and Gode, K. D., (1952), *Ibid.* **14**, 212.

79 Bose, B. C., Gupta, S. S., Vijayvargiya, R., Saifi, A. Q. and Bhatnagar, J. N. (1957), Curr. Sci., No. 9, 278.

80 Srivastava, S. K., Dhar, M. M. and Kohli. J. D. (1957), J. Sci, Industr. Res., **16C**. 73.

81 Bhattacharji, S., Dhar, M.M. and Dhar, M.L. (1957), J. Sci. Industr. Res., **16B**, 97.

82 Bose (Mrs.), B. (1957), J. and Proc. Inst. Chem., **29**, 166.

83 Chatterjee, M.L., De, M.S. and Sen, G.P. (1957), *Ibid.*, **5**, 21.

84 Sen, G.P., Banerjee, R.P. and Chatterjee, M.L. (1957), *Ibid.*, **5**, 66.

85 Chatterjee, M.L., De, M.S. and Sett, D. (1957), *Ibid.*, **5**, 172,

86 Chatterjee, M.L. and De, M.S. (1957), *Ibid.*, **5**, 173.

87 Chaudhuri, R.N., Chakravarti, R. N., Bhattacharyya, A. and Basu, S.P. (1957), *Ibid.*, **5**, 53.

88 Chakraborty, H.C. and Chakraborty, D.P. (1957), Sci. & Culture, **23**, 56.

89 Guha, B.C. and Das, M. L. (1957), Nature, **180**, 1285.

90 Das, M.L. and Ghosh, N.C. (1957), Indian J. Med. Res., **45**, 631.

91 Das, M.L. and Guha, B.C. (1957), Sci. and Culture, **23**, 156.

92 Prasad, S. and Kaul, P.N. (1957), Indian J. Pharm., **19**, 131.

93 Singh, T., Paul, V. and Handa, K.L. (1957), *Ibid.*, **19**, 187.

94 Handa, K.L., Singh, H. and Malhotra, M.K. (1957), J. & Proc. Inst. Chem., **29**, 206.

95 Bhattacharyya, A. (1956), Sci. & Culture, **22**, 120.

96 Mukerjee, S.R., Maiti, A. and Dey, P. K. (1957), Nature **180**, 916.

97 Murthy, B. R. and Srinivasan, V. R. (1957), Curr. Sci., **26**, 50.

98 *Idem* (1957), J. Sci. Industr Res., **16C**, 59.

99 *Idem* (1957), Proc. Indian Acad. Sci., **46A**, 53.

100 Moudgal, N.R., Srinivasan, V. and Sarma, P. S. (1957), J. Nutrition **61**, 97.

101 Chaudhury, S. S., Singh, H. and Handa, K. L. (1957), Curr. Sci., **26**, 148.

102 Raha, C. R. (1957), Sci. & Cult., **22**, 637.

103 Barua, A. K. (1957), *Ibid.*, **23**, 154.

104 Shankar, J. V. and Bharucha, F. R. (1957), *Ibid.*, **23**, 193.

✓ 105 Rao, P. S. (1957), J. Sci., Industr. Res., **16A**, 138.

106 Gupta, S. R., Pankajamani (Miss), K, S. and Seshadri, T.R. (1957), *Ibid.*, **16B**, 154.

✓ 107 Baruah, H. K., Raghavan, V. and Murthy, K. N. (1957), *Ibid.*, **16C**, 89.

108 Rangaswami, S. and Rao, E. V. (1957), *Ibid.*, **16B**, 209.

109 Macmillan, W. G., Nag, S. and Chakravarti, I. B. (1957), *Ibid.*, **16B**, 418.

✓ 110 Macmillan, W. G., Sen Gupta, A. B. and Dutt, A. S. (1957), Nature, **180**, 1041.

✓ 111 Mukerjee, S. and Shrivastava, A. N. (1957), J. Sci. Industr. Res., **16B**, 566.

112 Bhat, S. G. (1957), *Ibid.*, **16A**, 563.

113 Das, D. B., Mitra, M. K. and Wareham, J. F. (1956), Proc. Nat. Inst. Sci., **22**, 377.

114 Ramakrishnan, T., Indira, M. and Sirsi, M. (1957), Nature, **179**, 1356.

115 Savur, G. R. (1957), J. Indian Chem. Soc., Ind. & News Ed., **20**, 55.

116 Subramanyan, V., Lal, G., Bhatia, D. S., Jain, N. L., Bains, G. S., Srinath, K. V., Anandaswamy, B., Krishna, B. H. and Lakshminarayana, S.K. (1957), J. Sci. Food Agric., **8**, 253.

117 Marathe, K. G. (1956), Sci. & Culture, **22**, 175.

118 Gupta V. N. and Seshadri, T. R. (1957), J. Sci. Industr. Res., **16C**, 71.

119 Chander, K. and Seshadri, T. R. (1957), *Ibid.*, **16A**, 319.

120 Ahluwalia, V. K. and Seshadri, T. R. (1957), *Ibid.*, **16B**, 323.

121 Pavanaram, S. K. and Row, L. R. (1957), *Ibid.*, **16B**, 409.

122 Ahluwalia, V. K. and Seshadri, T. R. (1957), J. Chem. Soc., 970.

123 Chibber, S. S., Ganguli, A. K., Mukerjee, S. K. and Seshadri, T. R. (1957), Proc. Ind. Acad. Sci., **46A**, 19.

124 Ganguli, A. K., Seshadri, T. R. and Subramanian, P. (1957), *Ibid.*, **46A**, 25.

125 Saxena, G. M. and Seshadri, T. R. (1957), *Ibid.*, **16A**, 218.

126 Aiyar, S. N., Dass, I. and Seshadri, T. R. (1957), *Ibid.*, **46A**, 238.

127 Murti, V. V. S., Seshadri, T. R., Sundaresan, V. and Venkataramani, B. (1957), *Ibid.*, **46A**, 265.

128 Laumas, K. R., Neelakantan, S. and Seshadri, T. R. (1957), *Ibid.*, **46A**, 343.

129 Govindachari, T. R., Nagarajan, K., Pai, B. R. and Parthasarathy, P. C. (1957), J. Chem. Soc., 545.

130 Govindachari, T. R., Nagarajan, K. and Parthasarathy, P. C. (1957), *Ibid.*, 548.

131 Bharucha, F. R. and Shankarnarayan, K. A. (1957), Sci. & Cult., **23**, 311.

132 Mitra, S. N. and Roy, S. C. (1957), J. & Proc. Inst. Chem. **29**, 155.

133 Nath, R. and Giri K. V. (1957), J. Sci. Industr. Res., **16C**, 5.

134 *Idem* (1957), *Ibid.*, **16C**, 51.

135 Jones, D. B. and Gersdorff, C. E. F. (1927), J. Biol. Chem. **75**, 213.

136 Nath, R., Rao, K. H. and Giri, K. V. (1957), J. Sci. Industr. Res., **16C**, 228.

137 Subramanian, N., Rao, M. V. L. and Srinivasan, M. (1957), *Ibid.*, **16C**, 24.

138 Ramachandan, B. V. (1957), *Ibid.*, **16C**, 17.

139 Apte, U. and Sohonie, K. (1957), *Ibid.*, **16C**, 225.

140 Joshi, M. R. and Sohonie, K. (1957), *Ibid.*, **16C**, 119.

141 Barucha, F. R. and Joshi, G. V. (1957), Sci. & Cult., **23**, 307.

✓ 142 Esh, G. C. and Som, J. M. (1957), Ann. Biochem. Exptl. Med., **17**, 19. ✓

143 Sarma, P. S. N. and Balsubrahmanyan, G. (1957), Curr. Sci., **8**, 248.

144 Osmani, (Mrs.) Z. H. and Naidu, M. B. (1956), Sci. & Cult., **22**, 235.

145 Sarkar, S. and Chakravarti, M. M. (1956), *Ibid.*, **22**, 336.

146 Chakravarti, M. M. and Palit, D. (1957), *Ibid.*, **22**, 464.

147 Sengupta, A. and Chakravarti, M. M. (1957), *Ibid.*, **22**, 581.

148 Chaudhury, S. S., Gautam, S. K. and Handa, K. L. (1957), Ind. J. Pharm., **19**, 183.

149 Chaudhury, S. S., Paul, V. and Handa, K. L. (1957), *Ibid.*, **19**, 290.

150 Narang, S. A. and Puntambekar, S. V. (1957), J. Ind. Chem. Soc., **34**, 135.

151 *Idem* (1957), *Ibid.*, **34**, 143.

152 Ganguly, N. C. and Bhattacharyya, B. K. (1957), *Ibid.*, **34**, 247.

153 Saraf, V. A. and Dole, K. K. (1957), *Ibid.*, **34**, 318.

154 *Idem* (1957), *Ibid.*, **34**, 383.

155 Phatak, K. D. and Agrawal, J. S. (1957), J. Sci. Industr. Res. **16B**, 19.

156 Patil, V. S. and Magar, N. G. (1957), *Ibid.*, **16B**, 43.

157 Chauduri, S. S., Singh, H, and Handa, K L. (1957), *Ibid.*, **16B**, 45.

158 Husatni, S. M., Rao, S. R. and Saletore, S. A. (1957), *Ibid.*, **16A**, 128.

159 Mitra, C. (1957), *Ibid.*, **16B**, 120.

160 Chowdhury, D. K. and Mukherji, B. K. (1957), *Ibid.*, **16B**, 175.

161 Ojha, V. N., Sharma, P. G. and Aggarwal, J. S. (1957), *Ibid.*, **16A**, 213.

162 Bhargava, P. P., Deshapande, S. S. and Haksar, C. N. (1957), *Ibid.*, **16B**, 427.

163 Roy, B. R. and Guha, B. C. (1957), *Ibid.*, **16C**, 231.

164 Roy, B. R. (1957), *Ibid.*, **16C**, 236.

165 Krishnaswamy, N., Govindan, K. P. and Pandya, R. N. (1957), Chem. & Ind., 1456.

166 Chiniwala, E. H. and Desai, C. M. (1957), J. Ind. Chem. Soc. Ind. & News Ed , **20**, 70.

167 Sinha, S., Chakrabarty, S. R. and Chakrabarty, M. M. (1957), *Ibid.*, **20**, 104.

168 Gupta, D. K., Iyengar, B. T. R. and Chakrabarty, M. M. (1957), *Ibid.*, **20**, 112.

169 Chakrabarty, S. K., Ganguly, D. and Goswami, M. N. (1957), *Ibid.*, **20**, 6.

170 Chakrabarty, S. R. and Chakrabarty, M. M. (1957), *Ibid.*, **20**, 17.

171 Mukherjee, D. K., Mitra, C. R. and Saha, A. N. (1957), *Ibid.*, **20**, 23.

172 Saha, J. G., Roy, P. and Chakrabarty, M. M. (1957), *Ibid.*, **20**, 25.

173 Upadhyaya, M. M., Ajmani, B. and Saha, A. N. (1957), *Ibid.*, **20**, 29.

174 Chakrabarty, S. R. and Chakrabarty, M. M. (1957), *Ibid.*, **20**, 33.

175 Pathak, S. P. and Dey, L. M. (1957), J. Chem. Soc., 1917.

176 Chakrabarti, M. M. and Bhattacharyya, S. (1957), Naturwiss., **44**, 91

177 Chowdhuri, D. K. and Bagchi, R. (1957), *Ibid.*, **44**, 263.

178 Varma, K. R. (1957), Ind. Soap J., **22**, 191.

179 Biswas, A. K. (1957), *Ibid.*, **22**, 211.

180 Sen Gupta, A. and Chakrabarty, M. M. (1957), Sci. & Cult., **23**, 306

181 Subrahmanyam, V. V. R. and Achaya, K. T. (1957), J. Sci. Food Agric., **8**, 657.

182 *Idem* (1957), *Ibid.*, **8**, 662.

183 Banerjee, S. C. (1957), Ind. Soap J., **22**, 257.

184 Narang, S. A. and Sadgopal (1957), *Ibid.*, **23**, 10.

185 Dhingrra, D. R., Gupta, G. N. and Agarwal, R. P. (1957), *Ibid.*, **23**, 67.

186 Biswas, A. K. (1957), *Ibid.*, **23**, 109.

187 Mittal, O. P. and Seshadri, T. R. (1957), Curr. Sci., **26**, 4.

188 Chatterjee, R., Srinivasan, K. S. and Maiti, P. C (1957), J. Amer. Pharm. Assoc.. **46**, 114.

189 Ghosh, H. and Guha Thakurta, A. K. (1957), Sci & Cult., **22**, 570.

190 Vora, V. C., Shete (Mrs.), K. and Dhar, M. M. (1957), J. Sci. Industr. Res., **16C**, 182.

191 Kalyanasundaram, R. and Subba Rao, N. S. (1957), Curr. Sci., **26**, 56.

192 Datta, J., Bhattacharya, K. R. and Roy, D. K. (1957), Ann. Biochem. Exptl. Med., **17**, 35.

193 Sepaha, G. C. and Bose, S. N. (1956), J. Indian Med. Assoc., **27**, 388.

194 Das, B. R., Kurup, P. A. and Rao, P. L. N. (1957), Indian J. Med. Res., **45**, 191.

195 *Idem* (1957), *Ibid.*, **45**, 197.

196 Sastry, K. S. and Sarma, P. S. (1957) Curr. Sci., **26**, 52.

197 Dakshinamurthi, C. and Biswas, N. R. D. (1957), *Ibid.*, **26**, 110.

198 Joshi, D. V., Tamhane, R. G. and Dutta, N. K. (1957), *Ibid.*, **26**, 147.

199 Palit, S. R. (1957), Sci. & Cult., **22**, 688.

200 Mitra, S. N. and Chatterji, R. K. (1957), *Ibid.*, **23**, 152.

201 Narayana, C. S. and Rangaswami, S. (1957), Indian J. Pharm., **19**, 3.

202 Patel, R. P. and Patel, K. C. (1957), *Ibid.*, **19**, 70.

203 Basu, N. K. and Rakhit, S. (1957), *Ibid.*, **19**, 205.

204 Bhatt, R. P. and Khorana, M. L. (1957), *Ibid.*, **19**, 208.

205 Patel, R. P. and Trivedi, B. M. (1957), *Ibid.*, **19**, 228.

206 Bose, B. C., Vijayvargiya, R. and Bhatnagar, J. N. (1957), Ind. J. Med Sci., **2**, 199.

207 Bose, B. C., Gupta, S. S., Bhatnagar, J. N. and Vijayvargiya, R. (1957), *Ibid*, **2**, 803.

208 Patel, R. P. and Trivedi (Miss), B. M. (1957), *Ibid.*, **2**, 887.

209 Bhide, N. K. and Sheth, U. K. (1957), *Ibid.*, **2**, 892.

210 Chakravarty, T. and Chatterjee, A. (1957), J. Indian Chem. Soc., **34**, 117.

211 Saha, S. K. and Chatterjee (Mrs.), A. (1957), *Ibid.*, **34**, 228.

212 Natarajan, C. P., Iyengar, J. R. and Bhatia, D. S. (1957), J. Sci. Industr. Res., **16C**, 42.

213 Macmillan, W.G., Basu, S.N. and Pal, P. N. (1957), *Ibid.*, **16A**, 135.

214 Lulla, B. S. and Johar, D. S. (1957), *Ibid.*, **16C**, 45.

215 Joshi, M. R. and Sohonie, K. (1957), *Ibid.*, **16C**, 68.

216 Sethi, S. C. and Aggarwal, J. S. (1957), *Ibid.*, **16A**, 181.

217 Varma, J. P., Dasgupta, S., Nath, B. and Aggarwal, J. S. (1957), *Ibid.*, **16B**, 162.

218 Mitra, C. (1957), *Ibid.*, **16B**, 167.

219 Macmillan, W. G., Basu, S. N. and Pal, P.N. (1957), *Ibid.*, **16C**, 95,

220 Pillai, N. C., Rao, G. J. S, and Sirsi, M. (1957), *Ibid.*, **16C**, 106.

221 Bhagavan, H. N. and Rajagopalan, R. (1957), *Ibid.*, **16C**, 115.

222 Narayanmurti, D., Rao, P.R. and Ram, R. (1957), *Ibid.*, **16B**, 377.

223 Rehsi, S. S. and Daruvala, E. D. (1957), *Ibid.*, **16A**, 428.

224 Siddappa, G. S. (1957), *Ibid.*, **16C**, 199.

225 Sastry, L. V. L. (1957), *Ibid.*, **16B**, 508.

226 Chaudhry, G. R. (1957), *Ibid.*, **16B**, 511.

227 Murthy, H. B. N., Anandaswamy, B., Srinivasan, K. S., Muthu, M., Iyengar, N, V. R. and Pingale, S. V. (1957), *Ibid.*, **16A**, 570.

228 Subrahmanyan, V., Sreenivasamurthy, V., Krishnamurthy, K. and Swaminathan, M. (1957), *Ibid.*, **16C**, 240.

229 Sharma, A. K. and Bal, A. K, (1957), Proc, Nat. Inst. Sci., **22**, 57.

230 Dutta, A. B. (1957), J. & Proc. Inst. Chem., **29**, 263.

231 Subba Rao, N, S. (1957), J. Amer. Pharm. Assoc., **46B**, 65.

232 Dandiya, P. C. and Arora, R. B. (1957), *Ibid.*, **46**, 111.

233 Giri, K. V., Krishnaswamy, P. R. and Rao. N. A. (1957), Nature, **179**, 1134.

234 Giri, K. V, and Krishnaswamy, P. R. (1957), *Ibid.*, **180**, 1427.

235 Narasimhan, N. S. (1957), Chem. & Ind., 661.

236 Kothari, N. J., Rindani, T. H. and Naik, M. G. (1957), Arch. Inst. pharmacodyn., **61**, 293.

237 Rao, T. L. N. and Datar, D. S. (1957), J. Ind. Chem. Soc. Ind. & News Ed., **20**, 75.

238 Ramaswamy, A. S. and Sirsi, M. (1957), Naturwiss., **44**, 380,

239 Banerjee, B., Chakravarti, R. N. and Chaudhuri, R. N. (1957), Bull., Cal, School Trop. Med., **5**, 71.

240 Banerjee, R. M. and Das, N. B. (1957), Ann. Biochem. Exptl. Med., **17**, 19.

241 Malakar, M. C. and Banerjee, S. N. (1957), *Ibid.*, **17**, 27.

242 Hatwalne, B. V. and Sohonie, Mrs. K. (1957), *Ibid.*, **17**, 45.

243 Mitra, B. R. and Chaudhuri, D. K. (1957), *Ibid.*, **17**, 49.

244 Hatwalne, B. V. and Sohonie, Mrs. K. (1957), *Ibid.*, **17**, 53.

245 Chakravarty, D.P., Das Gupta, A. and Bose, P.K. (1956), *Ibid.*, **17**, 59.

246 Banik, U. K. and Chakravarti. H. S. (1957), *Ibid.*, **17**, 139.

247 Subrahmanyan, V., Lulla, B. S. Rao, M. N., Johar, D. S. and Swaminathan, M. (1957), *Ibid.*, **17**, 155.

NUTRITION

S. M. PATEL & M. V. RADHAKRISHNA RAO

Department of Nutrition, Haffkine Institute, Bombay

Introduction

The subject is reviewed under the four heads: (i) Nutritive value of foodstuffs, (ii) Diet and nutrition surveys, (iii) Clinical and physiological studies, and (iv) Protein malnutrition. On going through the literature, it appears that considering the clinical material available in the country for investigations, it has not received the attention of the workers that it deserves. It augurs well that adequate emphasis has been laid on the subject of 'nutrition' among others from various aspects under the Medical Research in the Second Five Year Plan. It is hoped that in the years to come more and more work will be forthcoming. Clinical studies on vitamins are covered under the review on 'Vitamins'.

Nutritive Value of Foodstuffs

The Department of Nutrition, Bombay[1] analysed 71 different foodstuffs commonly consumed in Bombay State about which no detailed information is available, for their chemical composition including vitamins. It is observed that most of the leafy vegetables, for example, alu (*Colocasia antiquorum*), *methi* (*Trigonella foenumgraceum*), *sepu* (*Peucedanum graveolens*), *rajgira* (*Amaranthus paniculatus*), *moras* (*Suaeda nudiflora*) *ghol* (*Portulaca oleracea*), etc., contain fairly good amount of minerals. These foodstuffs are particularly rich in carotenes and also fairly rich in vitamin C. Amongst fruits, the five varieties of mangoes analysed are very rich in vitamin A and fairly rich in thiamine, riboflavin and vitamin C. *Goras amli* (*Pithecolobium dulce*) is found to be a new rich source of vitamin C (120 mg/100g.). Of oil seeds, charoli (*Buchanania lanzan*) is very rich in thiamine and riboflavin, while niger seeds (*Guizotia abyssinica, Cass*) are especially rich in riboflavin. Pulses before and after germination were studied for their vitamin C values and it was found that sprouting of pulses increases on an average vitamin C content by twenty fold.

Six common pulses, five millets, seven leafy vegetables, etc., were analysed microbiologically for their essential amino acids. In general, these foodstuffs are low in phenyl alanine, methionine and threonine compared to egg and milk proteins. The values reported for 16 foodstuffs for their biological value and digestibility co-efficient, fairly resemble those for good quality proteins.

Banerjee and Das [2] analysed thirteen varieties of wheat grown at the General Breeding Station, Niphad (Bombay) for proximate composition, calcium, phosphorus and nicotinic acid. Subrahmanyan *et al.*[3] determined the chemical composition of the drum dried banana powder (Poovan variety). The inclusion of the banana powder in synthetic or rice diets resulted in a lower absorption of nitrogen and three-fold increase in the faecal weight in rat. The authors have discussed the significance of these results in the light of earlier reports on therapeutic properties of banana in diarrhoeas.

The protein efficiency rations of some common cereals and pulses were re-evaluated at 10 per cent level of protein intake for 4 weeks, in weanling albino rats, by Phansalkar *et al.*[4] The effect of incorporating a pulse and/or a green leafy vegetable like *amaranth* without altering the total protein intake was also studied. Such various vegetable protein mixtures tried in this investigation were capable of maintaining the average normal levels of haemoglobin and plasma protein in the blood of albino rats. Based on these observations, the authors have concluded that it is practicable to obtain through a proper combination of vegetable foodstuffs, protein mixtures of high biological value comparable with skim milk protein.

The trypsin-inhibitor present in double bean (*Faba vulgaris Moench*) was shown by Apte and Sohonie [5] to markedly affect the rate of tryptic hydrolysis of proteins of skim milk and wheat flour. While studying the release of amino acids, they observed that the release of some amino acids was selectively inhibited; the inhibition gradually decreased with the progress of digestion. The purified inhibitor fed to rats at 0.265 per cent level of the diet did not, however, inhibit their growth.

Pai [6,7] reported results of analysis of 39 articles of food for their ash, moisture, thiamine, riboflavin, nicotinic acid and ascorbic acid content in their precooked and cooked states. Significant losses in these vitamins occurred during washing of the articles of food, particularly vegetables. Deterioration in vitamins during cooking depended upon the temperature and its duration. There was a wide variation in the losses of the vitamins from food to food. However, a large portion of vitamin C was destroyed in almost all foods studied.

Banerjee and Biswas [8] carried out laboratory analysis of cooked diet consumed by students of the Eden Hindu Hostel attached to the Presidency College, Calcutta, for various nutrients, *viz.*, proximate principles, minerals, vitamins and essential amino acids. The food was collected for a period of six consecutive days during the months of April, August and December representing three distinct seasons of the year. From the data, the daily intake of various nutrients of the students was worked out. It was observed that the diet was deficient in protein, calories, calcium and thiamine.

Mitra and Chaudhuri [9] determined the bound and the total nicotinic acid in 17 different varieties of rice samples, before and after cooking. They reported that the major portion of the nicotinic acid is in the combined state. When the rice samples were cooked with sufficient distilled water of pH about 6.6 for about 45 minutes, a part of the nicotinic acid was lost in the gruel, but the ratio of total nicotinic acid to bound form remained practically the same as before cooking. On the other hand, when the tap water of pH about 8.4 was used as a cooking medium, the ratio was lowered, indicating that alkaline pH liberated a portion of the nicotinic acid present in the bound form.

The changes in ascorbic acid, thiamine, riboflavin and nicotinic acid content of green peas (*Pisum sativum*) during blanching, autoclaving and storage have been reported by Malakar and Banerjee.[10] During blanching, ascorbic acid was lost to an extent of about 23 per cent, thiamine to 16 per cent, riboflavin to 27 per cent and nicotinic acid to 6 per cent. Autoclaving resulted in further losses in varying proportions in these vitamins except riboflavin. The total loss of the vitamins increased progressively with the duration of storage. The riboflavin content, however, increased during 6 months storage to nearly double of what remained after autoclaving.

Balasubramanian and Ramachandran [11] estimated microbiologically threonine and arginine in several varieties of five Indian careals, *viz.* rice, wheat, *ragi*, cholam and cambu. The threonine content of the cereal proteins is of the order of 3 to 4 per cent, while the arginine content is 5 to 10 per cent. Nath *et al.*[12] analysed the protein fractions isolated electrophoretically from sesame seed meal for their amino acid contents by the circular paper chromatographic technique. They observed that the globulin fractions contained more of the sulphur bearing amino acids, cystine and methionine and the basic amino acids, arginine, histidine and lysine than the whole meal. Ramachandran [13] analysed six common oil-seeds cakes for their arginine content. *Til* and ground-nut cakes are shown to be good sources of this amino acid.

Using microbiological methods, the concentrations of the ten essential amino acids in the casein hydrolysate prepared by a pancreatic and ereptic digestion, have been determined and the values compared with those of casein and whole egg (Ramsarma and Rao [14]). Rat feeding experiments have also been carried out to compare the nutritive value of the casein hydrolysate with that of casein. The rate of growth, digestibility co-efficient, biological value and nutritive index of the hydrolysate compared very favourably with those of casein.

Valanju and Sohonie [15–18] have described in detail a method for the isolation and purification of fish proteins. Chemical analyses of proteins so obtained from 8 varieties of fishes indicated that they were 85 to 90 per cent pure. The distribution of nitrogen, the α-amino nitrogen and the amino acid make-up of fish proteins was studied. Ghol and Mandeli proteins contained all the essential amino acids in significant amounts. The *in vitro* enzymatic hydrolysis of partially purified fish proteins by the combined action of pepsin and trypsin is also reported. The biological value of fish proteins was assessed by five different methods and it showed that these proteins possessed high biological values. The suitability of rice-moth larvae as test animals for evaluating the nutritive value of proteins is indicated. Venkataraman and Chari[19] studied the essential amino acid composition of five marine fishes by the paper chromatographic technique. They have shown that the amino acid composition of fish proteins compared well with the protein from other animal sources. While the general pattern of the amino acid make-up was the same in almost all the fishes studied, the absence of tryptophane in the sardine group of fishes and richness of pomfret in leucines are to be particularly noted. The same authors (Chari and Venkataraman[20]) showed that the preservation of prawns by the process of semi-drying does not alter its food value to any appreciable extent as judged by a comparison of the proximate composition and the amino acid picture of the proteins of the raw as well as the preserved prawns.

The Central Food Technological Research Institute, Mysore has developed a process for the large scale manufacture of Indian multipurpose food (IMPF). Joseph *et al.*[21] have compared the over-all nutritive value of this preparation with the American multipurpose food (AMPF) by incorporating at 40 per cent level in the diet of young rats. The results did not show any significant difference between the two groups as judged by growth, red blood cell counts and liver and body moisture, protein and fat. On the other hand, the rats fed on a diet containing IMPF had a slightly higher content of hæmoglobin. It was also found to support reproduction and lactation of rats. The same Institute (Kuppuswamy *et al.*[22]) has also reported that both Indian and American multipurpose foods when incorporated at 12.5 per cent level had a marked supplementary value to the poor vegetarian diets based on rice, wheat, *jawar* and *ragi* and between them there was no significant difference with respect to their supplementary value to the different diets. A similar study was made by Joseph *et al.*[23] using Italian millet (*Setaria italica*) and little millet (*Panicum milliare*). Here, American multipurpose food was found to be slightly superior to IMPF in its supplementary value to the diet based on little millet. The same group of workers (Joseph *et al.*[24])

observed the relative value of the proteins in IMPF, Bengal gram and skim milk powder in meeting the protein requirements of protein depleted rats. The diets contained 14 per cent protein from respective foods. The ability of the three different foods to meet the protein requirements of the protein—depleted rats ranged in the following descending order: skim milk powder, IMPF and Bengal gram. Joseph *et al.*[25] also determined the effect of supplementation of IMPF on the metabolism of nitrogen, calcium and phosphorus in under-nourished children. The experimental group received daily in addition to the basal rice diet, 2 oz. of IMPF in the form of soup or chutney. The results showed that all the subjects in the experimental group retained a greater amount of nitrogen, calcium, and phosphorus as compared with the control group.

Feeding experiments with an infant food prepared from buffalo milk were conducted at three centres under strict medical supervision on about 75 infants (Chandrasekhara *et al.*[26]). The infant food contained 22 per cent protein and 14 per cent fat and was fortified adequately with vitamins A and D. The results showed that all the infants digested the food readily. The infants consumed the reconstituted milk with great relish and there was no cases of vomiting after the ingestion of the milk. The average rate of growth of the infants was quite satisfactory comparing well with the average rate of growth of Indian infants.

Siddappa and Bhatia[27] carried out supplementary feeding experiments on rats, using the fresh jack fruit, with or without the addition of a small quantity of honey to the basal rice diet. The diets were fed *ad libitum* over a period of 12 weeks. They did not observe any supplementary effect as determined by growth, and calcium and phosphorus retention. Similar observations are reported by them (Siddappa and Bhatia[28]) using orange juice powders.

Srinivasan *et al.*[29] observed the goitrogenic effect of groundnut in albino rats. The goitrogenic factor appeared to be water soluble and could not be identified with any of the known dietary goitrogens. This effect was inhibited by dietary supplements of small amounts of iodine as potassium iodide. The same laboratory (Moudgal *et al.*[30]) has subsequently reported that the goitrogenic property of the groundnut is due to the presence of the glycoside, arachidoside in the red skin of the nuts. As a result of the study of phenolic excretion in the urine of rats, it is suggested that the effect was due to preferential iodination of the phenolic metabolites in the thyroid tissue.

Bhagawan *et al.*[31] have compiled the values on the sodium content of different foods available in the literature to facilitate the construction of low sodium diets for therapeutic purposes.

Diet and Nutrition Surveys

A study of the dietary habits and dietary intake of the Dangi families, a clinical nutrition survey of the representative school children of the Dangs District and a clinical appraisal of the incidence of deficiency states in the district was carried out by the Department of Nutrition (Rao[32]). 42 families representing all the six ranges of the Dangs District (Bombay State) were visited. Detailed enquiries made about the food intake showed that Dangis are vegetarian perforce ; they resort to fleshy foods, whenever an opportunity arises. *Nagli** is the staple food for the greater part of the year. The intake of milk and milk productes, fresh vegetables and fruits is negligible. The diet was thus mainly composed of starchy foods, such as cereals, and tubers. The calcium content of the diet was high due to a very high intake of calcium-rich *Nagli*. On the other hand, the diet was inadequate in quantity and revealed a deficiency in proteins (mainly animal protein), fats, vitamin A and vitamin C. The dietetic conditions in the three residential institutions in the area were slightly better due to the efforts made by the hostel authorities to grow fresh vegetables near the premises for their consumption.

*** Composition of Nagli-diet**

Ragi or Nagli (*Eleusine coracana*) is grown in the District of Dangs. It is, therefore, a staple food for the greater part of the year. The composition of average diet of the Dangi family is as follows (per head (C. U. 1)/day in ounces) : Ragi or Nagali (*Eleusine coracanu*) 20.3 ; Jowar 0 7 ; Maize 0.7 ; Wari 0.6 ; Pulses 0.8 ; Leafy vegetables 0.13 ; Root vegetables 0.01 ; Other vegetables 1 0 ; Fruits 0 ; Sugar and jaggery 0 ; Vegetable oils/fats 0.1 ; Butter and ghee 0 ; Milk, curds 0.9 ; Fish (dry) 0.04 ; Eggs 0 ; and Red chillies 0.2.

The clinical nutrition examination of school children showed a high incidence of malnutrition, generalised under-nourishment, stunted growth and marked deficiency of vitamin A. The inmates of the hostel showed a slightly better health and physique. This is attributed to the greater consumption of 'protective foods' by them. Malaria and other fevers, conjunctivitis, non-specific diarrhoeas, tropical ulcer, 'cough and colds', dyspepsia and general debility have been found to be the common ailments amongst the adults. Protruded abdomen (pot belly) has been very common amongst the women, particularly the mothers. Examination of stool samples did not indicate any evidence of helminthic infection (such as ankylostomiasis). Hæmatological examination showed secondary anæmia (due mainly to iron-deficiency) in most of the patients of Government Dispensaries.

The Department of Nutrition, Bombay (Rao [33]) studied more than 600 diets in nearly 350 institutions, spread over 19 districts of the then Province of Bombay, during the five years 1945-50. The salient observations reported are the diets have been found to be generally deficient in 'protective foods', like milk, fresh vegetables, fruits, fleshy foods, fats; and inadequate in quantity and quality. The diets of college and school hostels have been found to be better than the other institutions which are financially not so better off. The Districts of Gujarat showed better consumption of milk than other districts.

A combined diet and nutrition study has been carried out by the same Department (Rao [34]) in the Sirur Health Unit Area in 1953-54. Of the 46 families surveyed, 27 were from the municipal area and 19 were from the non-municipal area. The average diets were not satisfactory, being low in 'protective foods.' The diet of the people in the non-municipal area was heavier in cereals and pulses than that of the municipal area. The average values of the nutrients were all below the recommended level, except for thiamine and iron.

A nutrition survey of 34 families (146 persons) and seven schools (663 school children) is reported. The nutritional status of the families examined was not very satisfactory. Men were better nourished than women and women were better nourished than children. On the whole, two-thirds of the children from this area were malnourished. The main deficiency signs were due to lack of fat and vitamin A such as deficient sub-cutaneous fat, dry skin, xerosis of conjunctivae. etc.

A similar survey has been carried out in the community Project Area at Karjat. A total number of 59 families in a village—Humgaon were examined, 25 families during May-June 1953 and 34 families in April-May 1954. The general observation recorded before that the intake of 'protective foods' increases with increase in economic status was confirmed.

A nutrition survey of 12 families (48 persons) and one school (44 school children) was carried out in April 1954 in the same area. The nutritional status of both the groups was not very satisfactory. Three out of every five persons and three out of every four children were malnourished. Men and women showed better nutritional status than children ; the nutritional status of girls was better than that of boys. The main deficiency observed was deficient sub-cutaneous fat. This observation is corroborated by the diet survey findings.

Out of nearly 240 families from the village of Humgaon 59 families were surveyed for the dietary habits. They were divided into three groups according to their economic status: (I) land. owners ; (II) land tenants ; (III) landless labourers. The average intake of each class of foodstuffs per consumption unit (C. U.) per day for each family and for each group were calculated from seven days' dietary data. It was observed that the average consumption of vegetable oils and fats is only 0.3 oz. per C. U. per day and is far too low, from the recommended level 2.0 ozs. per C. U. per day.

The clinical examination of 12 families also showed the sign of fat deficiency and deficient sub-cutaneous fat. The assessment of sub-cutaneous fat was made by physical examination of the extremities and other parts of the body. It is in main based on the subjective observation of the examining physician.

The intake of calories is adequate in group I and II. In group III, it is very low. In all the groups, cereals contributed the major portion of calories.

The Department of Nutrition (Rao[35]) carried out another similar survey of the lower middle class families in some parts of the D-ward of Bombay City. The basis of selection of families was payment of monthly rent between Rs. 16 to 30. 267 families were included for dietary survey and 251 families for nutrition survey. The diets of these families have been observed to be low in calories and 'protective foods'. The average values for the nutrients like proteins and calcium were below desired level. The intake of 'protective foods' increased with the income per consumption unit per month.

A total number of 1256 persons (659 males and 597 females) from 251 families were clinically examined. Of these, 72 per cent had been found in satisfactory nutritional status, 26 per cent were under-nourished and only 2 per cent showed evidence of mal-nutrition. The deficiencies commonly observed were mainly due to low intake of protein, fat, vitamin A and calories. Evidence of mild anaemia was observed nearly three times more in women than in men.

The average heights of children were very near the standard heights and the average weights were slightly lower than the standard weights in some age groups. The average heights of the adult men and women were 65.0 and 58.9 inches respectively and the average weights were 121.3 and 106.9 lbs. respectively.

Rao[36] reported on the dietary studies in 108 industrial canteens in Bombay State carried out during the period 1950-56. In this report, he has made interesting observations and has stressed the importance of feeding industrial workers through canteens to improve the nutritional status of the workers.

A diet and nutrition survey of 40 families of industrial workers from Swadeshi Mills, Kurla, Bombay was carried out in April-May 1955 (Rao[37]). All the families surveyed were non-vegetarian and speak Marathi. The average income per C. U. per month was Rs. 36. The data collected showed that the average dietary intake as well as nutritional status of this industrial population is not satisfactory. The diets were deficient in proteins, fats, calcium, vitamin A and vitamin C. The main deficiency symptoms observed were under-nourishment, hypovitaminosis A and anaemia. The previous findings in similar surveys (*loc cit.*) that men are better nourished than women and adults are better nourished than children were confirmed. The average heights of men and women were nearly same as those of corresponding middle class adults of Girgaum (' D ' ward, Bombay City) (*loc-cit.*); while the average weights are less than those of Girgaum adults.

The studies, comprising of laboratory and field investigations, on the possible nutritional factors in the causation of high incidence of vesical calculus in Mehasana District (Bombay State) are reported by the Department of Nutrition (Rao[38]). The dietary study included 55 families belonging to the lower middle class and agriculture/labour class, and 7 residential institutions. The nutrient analyses of the diets consumed revealed that the diets were fairly adequate in calories, but these were mostly derived from cereals and starchy foods. Moreover, on account of the low consumption of ' protective foods ' like milk and milk products, green leafy vegetables and fruits, etc., the diets were deficient in animal proteins, calcium, vitamin A and vitamin C.

The clinical nutrition examination of about 1,600 representative school children has revealed a high incidence of generalised under-nourishment and stunted growth. This is largely attributed to a low intake of ' protective foods ' by the population in general. Clinical appraisal of stone cases has shown higher incidence in males—both boys and adults. This diseased condition was found more common in the age group 0 to 10 years.

On chemical examination, drinking water was found to be excessively hard, the degree of hardness varying from place to place. Data are presented on the chemical composition of 35 representative stones. The majority of them are mixed stones composed mainly of oxalates, phosphates as salts of calcium and magnesium and/or urates. No direct correlation between the nature of hardness of water and the composition of vesical stones is indicated.

Based on the above findings, it is suggested that although the extent of hypovitaminosis A is not significantly higher than in similar population groups in other districts (*loc. cit.*), it may be a predisposing factor, particularly when the drinking water is excessively hard.

Banerjee and Biswas [39] studied the nutritional status of the students of the Eden Hindu Hostel, Calcutta. The students showed normal blood picture ; so also was their vitamin C and vitamin D nutrition. No abnormality was noticed in their carbohydrate, protein and fat metabolism.

Clinical and Physiological Studies

The response of the blood sugar levels to the administration of different cereal diets containing identical amounts of carbohydrate was investigated by Ramanathan and Gopalan [40] in six normal subjects and in two cases of glycosuria. The rise in blood sugar level following the administration of *ragi* was significantly less than that following the administration of rice. Similar difference was noticed between rice starch and *ragi* starch but not with the hydrolysates of the two starches. It is suggested that the differences observed between the two cereals were probably attributable to variations in the breakdown and absorption of the carbohydrates contained in them. In a similar study at Mysore, Srinivasan [41] determined the effects on blood sugar levels and glucose tolerance of ingesting known quantities of certain protein foods and proteins in 3 hyperglycaemic men and 2 healthy men. Casein, the protein from tender dolichos (*Dolichos lablab*) and the protein from black gram (*Phaseolus mungo*), as also black gram itself, were effective. *Tur dhal* (*Cajanus cajan*), the protein from mature dolichos, gelatin, and a mixture of amino acids as in casein were less effective. In addition to variation due to proteins, the effects varied with the individuals studied. The author has discussed the possible mechanisms for the observed effects, and the significance of the results.

Banerjee and Laskar [42] determined in different groups of people of Assam, the blood sugar, total non-protein nitrogen and its different fractions in winter and summer seasons to find the average standards. It was found that in winter both male and female subjects showed an average blood sugar level above 100 mg. per cent. In summer, the army personnel and male subjects showed an average below 100 mg. per cent and the civilian normal lactation.

The influence of pulse proteins—Bengal gram and lentil, on the promotion of xanthine oxidase activity in the liver was studied by feeding them to rats at different stages of growth and maintenance with and without supplementation of methionine (Esh and Som[50]). With adult rats, the enzyme level with the pulse diets was lower than that with the casein diet. However, a similar difference was not noticed with weanling rats, and in protein depleted adult rats, between the two proteins. The supplementation of pulses with methionine resulted in increased enzyme activity in all cases.

Ganapathy *et al.*[51] showed that the supplementation of Italian millet with lysine improved the utilization of millet protein. The differences in total nitrogen, certain amino acids in the liver, kidney and muscles of rats fed casein, millet and millet plus lysine were in accordance with growth. The results expressed on the basis of 16 per cent nitrogen, however, did not show any significant difference. It was therefore, concluded that the dietary deficiency does not alter the amino acid composition of the tissues.

The *in vitro* lability of methionine to radiations from radon sources was investigated using samples of methionine S^{35} and methionine $C^{14}H_3$ by Kumta *et al.*[52] It was shown that one of the earliest events in the degradation of methionine was the severance of $-CH_3$ grouping leaving a comparatively radio-stable homo-cysteine-like skeleton. However, with increase in the radiation dose, even S^{35} atoms were knocked off leaving amino acid-like compounds resembling threonine, aspartic acid, serine, glycine, etc. The probable pathways of oxidation degradation of methionine have been discussed. The same authors (Kumta *et al.*[53]) in an another investigation on the fate of administered methionine S^{35}, half an hour prior to irradiation, observed that such animals excreted 5 times more activity in the inorganic salt fraction, viz. barium sulphate than that found in control group. The uptake of S^{35} radio-activity in liver, kidney and spleen was consistently lower, while the uptake in the circulating blood and bone marrow was increased after total body irradiation. Nerurkar *et al.*[54] have shown on total body X-ray irradiation of rats with

600 r, two fold increase in the excretion of urea, uric acid and creatinine which persisted for 4-5 days and then dropped below the normal levels and continued at the sub-optimal levels for a considerable time. In animals given therapeutic doses of methionine half an hour after irradiation, the levels of the above metabolities were only one and a half times of the control values. The values returned to normal by the second day, and later fell below normal levels as in the irradiated group of animals. The significance of these results is discussed. From the same laboratory (Kumta *et al.*[55]), it was shown that creatine phosphate and ATP levels decreased by about 33 per cent, while those of inorganic phosphorus increased 4 times in the muscle of irradiated rats. Excretion of creatinine, creatine, and N^1-methylnicotinamide in urine was increased in varying proportions. It is suggested that the low levels of creatine phosphate were probably due to (i) an impairment in the phosphorylation of creatine or (ii) breakdown of creatine phosphate. Baxi *et al.*[56] have studied the *in vitro* glycogen synthesizing capacity of livers of irradiated rats at various intervals, with and without addition of substrates like glucose, amino acids and Kreb's intermediates. No significant difference was observed between the control and experimental group.

Protein Malnutrition

Patel[57] reported on 90 cases of protein malnutrition in children. He observed a diminution of serum proteins in all grades of malnutrition and the absence of any correlation between the protein levels, the degree of oedema and the clinical status. Hepatomegaly was found in 1/3 cases in varying degrees. Liver biopsy did not reveal any differences in various degree of malnutrition. In some cases muscle biopsy was also done which did not indicate extreme changes as recorded by others. Subsequently, Patel *et al.*[58] have reported on the paper electrophoretic pattern of serum proteins in such cases. They have observed a lowering in albumin and *beta* globulins and a rise in *gamma* globulin. There was a variation in *alpha* globulins. Severe skin lesions were encountered in the oedema group. It is suggested that rise in *gamma* globulins and the severity of the skin changes may be some of the manifestations of a severe biochemical abnormality in protein malnutrition. Udani [59] presented a clinical history of 25 cases of severe malnutrition in hospitalised children.

Rao and Gopalan [60] estimated six amino acids in the hairs of a series of 6 normal Indian children, 6 African cases of kwashiorkar in different stages of treatment, and of 15 Indian children with kwashiorkar and simple undernutrition. They observed a significant reduction in the cystine content of the hair in cases of protein malnutrition, irrespective of the fact whether the hair is discoloured or not and that this abnormality was reversed after a few weeks of treatment with high protein diet. There was no correlation between dyschromatrichia and the content of amino acids investigated. They have suggested that cystine content of the hair may be a better indication of the severity of protein malnutrition than the hair discoloration.

Chaudhury *et al.*[61] reported preliminary studies on 12 cases of marasmic children from various aspects such as clinical, haematological, biochemical, cytochemical and histological.

Subrahmanyan *et al.*[62] tested the efficiency of the Indian multipurpose food (IMPF) in the treatment of nutritional oedema syndrome. Three children suffering from typical kwashiorkar were administered 4 to 5 oz. per day of IMPF in four doses as gruel sweetened with 2 to 3 teaspoonfuls of sugar. A marked improvement in the general condition of the patients was observed in 8 to 10 days Complete disappearance of oedema and skin lesions was noticed in about 3 to 4 weeks. Total gain in weight in 6 to 8 weeks time was about 7 to 8 lbs.

Jayalakshmi *et al.*[63] studied the serum levels of sodium, potassium, calcium and magnesium, prothrombin time, etc., in two groups of kwashiorkar, consisting of 29 cases, before and after treatment with high protein diets containing 60 and 100 g. of protein. Serum potassium and magnesium concentration in cases of kwashiorkar were within normal limits; subnormal levels of sodium and calcium rose to normal after high protein treatment. Prothrombin values also returned to normal after treatment. A number of cases of kwashiorkar, which failed to show a satisfactory eosinopenic response to adrenalin, showed a satisfactory response after high protein diet treatment. Between the two diets no significant difference was noticed with regard to either serum albumin regeneration or clinical improvement.

Mukerjee and Nath [64] have reported the glucose-6-phosphatase activity of liver obtained on biopsy materials of 6 babies having classical kwashiorkar and 6 having marasmus. The blood sugar and liver glycogen were also estimated. Increase in glucose-6-phosphatase and alteration in other values were obtained after the patients were cured on a high protein diet. The implications of these observations are discussed by the authors. Mukherjee [65] recorded decreased choline esterase and alkaline phosphatase activity in 47 subjects of nutritional oedema and 17 children suffering from classical kwashiorkar.

Srikantia and Gopalan [66] tested the validity of the urea method for estimation of total body-water in malnutrition. For the purpose, they estimated total body-water in five normal adults and five malnourished oedematous patients by the urea and antipyrin methods. No significant difference was observed in the values obtained for both the groups by the two methods. These results indicate that the urea method is suitable for the estimation of total body-water even in mal-nourished patients.

In order to understand the occurrence of oedema only in certain types of protein malnutrition and not in others, Gopalan and Ramanathan [67] investigated the response to water load in three groups of monkeys which had been fed on control, high-calorie-low-protein and low-calorie-low-protein diets. A measured quantity of water equivalent to 5 per cent of body weight was administered to each animal by stomach tube. The animals were kept in metabolic cages and the urinary out-put was recorded every 30 minutes for the next four hours. The animals on control, low-calorie-low protein and high-calorie-low-protein diets excreted respectively on the average 92.77 and 50 per cent of the administered water in 4 hours. There was no correlation between duration of feeding of the different diets and the response to the water load tests. In one batch of animals the tests were repeated in which immediately after the water was administered each animal was also given 0.8 units of pitressin subcutaneously to determine whether the extent of anti-diuresis induced by pitressin was different in the different groups. This caused a 27, 36 and 67 per cent reduction in the response to water load in control, low-calorie-low-protein and high-calorie-low protein diets respectively. The plasma protein concentrations determined in the two experimental groups were not significantly different. The results obtained indicate that the response to water load tests was most impaired in animals on a high-calorie low-protein diet. Animals on the low-calorie-low-protein diet, on the other hand, showed relatively much less impairment. The reasons for this difference are not borne out by these studies.

REFERENCES

1 Annual Report (1957), Department of Nutrition, Government of Bombay, Bombay.

2 Banerjee, R. M. & Das, N. B. (1957), Ann. Biochem. Exptal. Med., **17,** 19.

3 Subrahmanayan, V., Lulla, B. S., Rao, M. N, Johar, D. S, & Swaminathan, M. (1957), *Ibid.*, **17,** 155.

4 Phanasalkar, S. V., Ramachandran, M. & Patwardhan, V. N. (1957), Indian J. Med. Res., **45**, 611.

5 Apte, U. & Sohonie, K. (1957), J. Sci. Industr, Res., **16C**, 225.

6 Pai, M. L. (1957), Indian J. Med. Res., **45**, 95.

7 *Idem*, (1957), *Ibid.*, **45**, 635.

8 Banerjee, S. & Biswas, D. K. (1957), *Ibid.*, **45,** 411.

9 Mitra, B. R. & Chaudhuri, D. K. (1957), Ann. Biochem. Exptal. Med., **17**, 49.

10 Malakar, M. C. & Banerjee, S. N. (1957), *Ibid.*, **17**, 27.

11 Balasubramanian, S. C. & Ramachandran, M. (1957), Indian J. Med. Res., **45,** 623.

12 Nath, R., Rao, K. H. & Giri, K. V. (1957), J. Sci. Industr. Res., **16C,** 228.

13 Ramachandran, B. V. (1957), *Ibid.*, **16C**, 70.

14 Ramasarma, G. B. & Rao, M. V. L. (1957), Indian J. Pharm. **19**, 92.

15 Valanju, N. N. & Sohonie, K. (1957), Indian J. Med. Res., **45**, 105.

16 *Idem*, (1957), *Ibid.*, **45**, 111.

17 *Idem*. (1957), *Ibid.*, **45**, 115.

18 *Idem*. (1957), *Ibid.*, **45**, 125.

19 Venkataraman, R. & Chari, S. T. (1957), *Ibid.*, **45,** 77.

20 Chari, S. T. & Venkataraman, R. (1957), *Ibid.*, **45,** 81.

21 Joseph, K., Rao, M. N., Swaminathan, M., Sankaran, A. N. & Subrahmanayan, V. (1957), Food Science, **6**, 80.

22 Kuppuswamy, S., Joseph, K., Rao, M. N. Rao, G. R. Sankaran, A. N., Swaminathan, M. & Subrahmanayan, V. (1957), *Ibid.*, **6**, 84.

23 Joseph, K., Rao, M. N., Swaminathan, M. & Subrahmanyan, V. (1957), *Ibid.*, **6**, 205.

24 Joseph, K., Rao, M. N., Sankaran, A. N., Swaminathan, M. & Subrahmanyan V. (1957), Annal. Biochem Exptal. Med. **17,** 103.

25 Joseph, K., Rao, M. N., Swaminathan, M. & Subrahmanayan, V. (1957), Food Science, **6**, 91.

26 Chandrasekhara, M. R., Doraiswamy, T. R., Swaminathan, M., Bhatia, D. S., Sankaran, A. N. & Subrahmanayan, V. (1957), *Ibid.*, **6**, 241.

27 Siddappa, G. S. & Bhatia, B. S. (1957), Annal. Biochem. Exptal. Med. **17,** 24.

28 *Idem.* (1957), *Ibid.*, **17**, 16.

29 Srinivasan, V., Moudgal, N. R. & Sarma, P. S. (1957), J. Nutrition, **61**, 81.

30 Moudgal, N. R., Srinivasan, V. & Sarma, P. S. (1957), *Ibid.*, **61**, 97.

31 Bhagawan, R. K., Swaminathan, M, & Subrahmanayan, V. (1975), J. Mysore Med. Ass., **22**, 1.

32 Rao, M. V. R. (1954), " Report of the Nutrition Survey of the Dangs District". Pages 1 to 52,

33 *Idem.* (1956), " Report on the Institutional Diets in Bombay State ". Pages 1 to 156.

34 *Idem.* (1956), " Diet and Nutrition Studies in Rural Areas In Bombay State (i) Sirur Health Unit, Sirur (Dist. Poona). (ii) Karjat Community Project Area (Dist. Kolaba)." Pages 1 to 107.

35 *Idem.* (1957). " Report on the Diet and Nutrition Survey of Lower Middle Class Families in D Ward, Bombay." Pages 1 to 169.

36 *Idem.* (1957), " Report on the Dietary Studies in Industrial Canteens in Bombay State." Pages 1 to 34.

37 *Idem.* " Report on the Diet and Nutrition Studies in An Industrial Area (Kurla, Bombay). *In Press.*

38 *Idem* " Report on the Studies on Vesical Calculus (Stone in the Urinary Bladder) in Mehsana District (1953-55), *In Press.*

39 Banerjee, S. & Biswas, D. K (1957), Indian J. Med. Res., **45**, 537.

40 Ramanathan, M. K. & Gopalan, C. (1957), *Ibid.*, **45**, 255.

41 Srinivasan, M. (1957), Lancet, 317.

42 Banerjee, B. & Laskar, G. K. (1957), Annal. Biochem. Exptal. Med. **17**, 107.

43 Pain, S. K. & Banerjee, S. (1957), Indian J. Med Res., **45,** 35.

44 Gopalan, C. & Ramanathan, K. S. (1957), *Ibid.*, **45**, 593.

45 Nath, H. P., Gupta, K. K. & Iyer, P. V. K (1957), *Ibid.*, **45**, 217.

46 Parekh, J. G., Mody, B. N., Jhala, H. I., Kothari, G.C., Dixit, C.H. & Ramasarma, G. B. (1957), Journal J. J. Gr. Hospitals & Grant Med, College, **2**, 317.

47 Ray Chaudhuri, B. (1957), Bull. Cal. School Trop. Med., **5**, 12.

48 Bose, A. N. (1957), Sci. & Cult, **22**, 240.

49 Ambegaokar, S. D. (1957), "Chronic Dietary Protein Deficiency in Experimental Animals." Ph. D. thesis, Poona University.

50 Esh, G. C. & Som, J. M. (1957), Annal. Biochem. Exptal. Med., **17**, 117.

51 Ganapathy, N. S., Chitre, R. G. & Gokhale, S. K. 1957), Indian J. Med. Res. **45**, 395.

52 Kumta, U. S., Gurnani, S. U. & Sahasrabudhe, M. B. (1957), J. Sci. Industr. Res., **16C**, 25.

53 *Idem.* (1957), *Ibid.*, **16C**, 111.

54 Nerurkar, M. K., Baxi, A. J. & Sahasrabudhe, M. B. (1957), *Ibid*,, **16C**, 175.

55 Kumta, U. S., Gurnani, S. U. & Sahasrabudhe, M. B. (1957), *Ibid.*, **16C**, 179.

56 Baxi, A. J., Sahasrabudhe, M. B. (1957), *Ibid.*, **16C**, 207.

57 Patel, B. D. (1956), Indian J, Child Health, **5**, 679.

58 Patel, B. D., Gaitonde, B. B. Jadhav, M. A. & Rao, G. S. (1957), *Ibid.*, **6**, 289.

59 Udani, P. M. (1956), Child Health, 117.

60 Rao, B. S, N, & Gopalan, C. (1957), Indian J. Med. Res., **45**, 85.

61 Chaudhuri, R. N., Mukherjee, K C. Chatterjee, J. B. Sen Gupta, P. C., Basu, S. P. & Mukherjee, A. M. (1957), Bull. Cal. Schl, Trop. Med., **5**, 150.

62 Subrahmanayan, V., Doraiswamy, T. R., Joseph, K., Rao, M. N. & Swaminathan, M. (1957), Food Science, **6**, 93.

63 Jayalakshmi, V. T., Ramanathan, M. K. & Gopalan, C. (1957), Indian J. Med. Res. **45**, 431.

64 Mukherjee, K. L. & Nath, R. L. (1957), Bull. Cal. Schl. Trop. Med., **5**, 171.

65 Mukherjee, K. L. (1957), *Ibid.*, **5**, 13,

66 Srikantia, S. G & Gopalan, C. (1957), Lancet, 1037.

67 Gopalan, C. & Ramanathan, K. S. (1957), Indian J. Med. Res. **45**, 65.

EXPERIMENTAL AND CLINICAL BIOCHEMISTRY

N. C. Dutta

Bangalore Medical College, Bangalore

During the period under review, published papers in clinical and experimental biochemistry cover a wide variety of subjects. The functional tests, such as glucose tolerance test, liver function tests and renal function tests have attracted the attention of a large number of workers. Electrophoretic analysis of serum proteins has been a popular subject with many of the investigators. A considerable amount of work on protein malnutrition in its various aspects is being carried out by Gopalan and co-workers at the Nutrition Research Laboratories, Coonoor. Researches on experimental atherosclerosis and alloxan-diabetes have been undertaken by Mukherjee and his colleagues at the Drug Research Institute at Lucknow and a number of papers has been published in these subjects. In spite of a vast amount of clinical material available at various hospitals in India, researches on clinical biochemistry have not received due consideration. It is hoped that with better co-operation from physicians and pathologists the clinical aspects of biochemistry will receive due attention.

Body Surface Area.—Banerjee and Sen[1] presented a nomogram for reading of surface area of the body of Indians in metric unit based on the equation,

$$\underset{(\mathrm{Cm}^2)}{\text{Surface area}} = \underset{(\mathrm{kg.})}{\text{Weight}}^{0\cdot425} \times \underset{(\mathrm{Cm.})}{\text{Height}}^{0\cdot725} \times 74.66$$

Nutritional.—Sastri and Indravati [2] determined the thiamine content of 125 samples of human milk from mothers at various stages of lactation. The average thiamine content of 93 samples of milk was 12.24 ± 0.19 μg. per 100 ml. The increase in thiamine content after one week of supplementation of 10 mg., daily, of crystalline thiamine hydrochloride was found to be significant.

Banerjee and Biswas [3] studied the nutritional value of cooked diet at the Eden Hostel, Calcutta and reported that the calorie consumption per student was less than the optimum requirement.

The diet was deficient in the protein content. The calcium intake was only 0.49 g. per day as compared with the recommended quantity of 1 g. per day. The diet was also deficient in thiamine content.

Jayalakshmi *et al.*[4] studied the response of cases of kwashiorkar at two different levels of protein intake. The results revealed no superiority of the diet containing 100 g. of protein daily as compared with the diet containing 60 g. of protein with regard to either serum albumin regeneration or clinical improvement. The subnormal values of serum calcium and slightly elevated levels of prothrombin time responded to high protein treatment. A number of cases of kwashiorkar which failed to show satisfactory eosinopenic response to adrenaline showed a satisfactory response to treatment with high protein diet.

The occurrence of striking changes in the hair has been recognised to be an important feature of kwashiorkar. Rao and Gopalan [5] reported a significant reduction in the cystine content of hair in cases of protein malnutrition, irrespective of the colour, and this abnormality is reversed after a few weeks of treatment with high protein diet. The authors suggest that the determination of cystine content of hair may be a better indication of severity of protein malnutrition than the hair discolouration.

Sathe *et al.*[6] reported that in cancer of mouth, there is a gross deficiency of thiamine and a moderate deficiency of riboflavin. A correlation was found to exist between the metabolism of vitamin B_1 and B_2 and estrogens in cancer patients. Estrogen treatment appears to be harmful in the case of cancer of the mouth as it induces a deficiency of thiamine and riboflavin. The authors suggest that a study of B vitamins in relation to precancerou lesions or cancer may prove useful in understanding their role in nutritional and hormonal imbalance.

Erythrocyte Sedimentation Rate: Konar [7] reported that erythrocyte sedimentation rate markedly increased in all the 13 patients with nephrotic syndrome and remained so as long as the syndrome was active. It is suggested that the test should be carried out to assess the activity of the syndrome along with the usual investigations, Bhatia *et al.*[8] found a close correlation between the severity of pulmonary tuberculosis and the serum glucoprotein in moderate and advanced cases, which represented 87% of the samples tested. Blood sedimentation rate and the hexose content gave a correct picture of the activity of the disease in 48% of the cases, while in 39% of the cases the blood sedimentation rate failed to indicate the extent of the disease.

Blood Volume: Basu *et al.*[9] carried out simultaneous estimation of blood volume employing the P^{32} tagged cell method and the dye-haematocrit method (T-1824). The authors concluded that the cell volume may be correctly determined by the tagged cell method, but for the estimation of correct total blood volume, the determination of cell volume by the tagged cell method and the plasma volume by the dye-haematocrit method may be helpful.

Blood Constituents: Nath *et al.*[10] estimated the serum cholesterol (free and esterified) and phospholipids of normal Indian service personnel varying in age from 20 to 60 years. The cholesterol content of the non vegetarians was found to be 16% more than the vegetarians. Smoking, alcoholic habits and racial differences seemed to have no significant effect on the levels of serum cholesterol. The lipid P was slightly less in the age group 20-30 years as compared to the other groups.

Gopalan and Ramanathan [11] carried out estimations of blood cholesterol in 447 healthy Indians belonging to different socio-economic groups. The blood cholesterol level was found to be higher in persons from high socio-economic groups than those of the poorer groups, specially in the advanced age groups. Similarly, in army officers, blood cholesterol levels were higher than those of sepoys, but the values were significantly higher in the 20 to 29 and 40 to 49 age groups. The significance of the above observations has been discussed in the light of the incidence of coronary heart diseases with different groups.

Jayalakshmi *et al.*[12] studied the blood of mothers belonging to the poor socio-economic group and of their infants. In spite of the relatively poor nutritional status of the mothers, the haematological findings, and the value for serum calcium and the total serum proteins were "similar to those reported elsewhere". The levels of the total cholesterol and cholesterol esters were also very similar to the values reported from other parts of the world. The inadequacies from malnutrition observed in maternal blood were not reflected in the blood of the new born, except for a slight lowering in the value of serum albumin.

Dixit *et al.*[13] reported that the serum vitamin B_{12} of cord blood was higher than that of the parturient mothers. The authors conclude that the foetus, like a parasite, draws the needed supply of B_{12} from mother's blood in excess of her serum level in order to maintain the hemopoietic activity and red cell production at a higher level consistent with anoxia.

The same authors[14] studied the absorption of vitamin B_{12} in apparently normal subjects. The results indicate that the serum level of B_{12} was much higher after intramuscular injection as compared with oral administration of the vitamin.

Narayan *et al.*[15] reported that intramuscular injection of 100 ug. of vitamin B_{12} on consecutive days in patients with nutritional macrocyclic anaemia produced a significant rise in the level of folic acid and a sudden elevation of in the level of B_{12} which rapidly fell during the next three days and then decreased slowly. In every case the trend of falling value of vitamin B_{12} was reversed in 24 to 48 hrs. after two daily injections of 25 mg. of folic acid, the maximum value being reached around the sixth day. A reciprocal relationship seems to exist between vitamin B_{12} and folic acid whereby large dosages of one tend to mobilize the other from the body stores.

Chatterjee *et al.*[16] reported that the significant drop in serum iron level consistently observed in all the ten patients of nutritional macrocytic anaemia (NMA) following successful therapy with antimegaloblastic drugs may be the earliest index of satisfactory erythropoietic response. The sharp hypoferremia which is regularly seen after successful therapy is presumably due to the rapid utilisation of circulatory iron for erythropoiesis which obviously outstrips the rate of mobilisation of "storage iron".

Ghosh[17] studied the effect of purified vitamin D_2 on the course of tuberculosis for a period of 9 months and observed a slight ameliorating effect in 8 chronic advanced pulmonary cases and a marked beneficial effect in 19 gland cases. Vitamin D_2 in high doses (600,000 I.U.) produced no hypercalcaemia in human beings. The average rise in serum calcium in 44 cases was 1.3 mg. per 100 c.c.

Nath and Chakravarty [18] observed a lowering of plasma potassium with concomitant increase in plasma sodium in patients who received solutions of sodium chloride, glucose and plasma substitutes during and after the operation. Forty-eight hours after operation, the plasma potassium and sodium returned to normal without any administration of potassium salt. No significant alterations of sodium and potassium were observed where blood transfusion was given. The authors stressed the superiority of blood in the correction of electrolyte imbalance after surgical operation.

Udwadia *et al.*[19] carried out metabolic studies of sodium and potassium in seven subjects recovering from congestive cardiac failure. The authors suggested that a disturbance of sodium metabolism and a derangement of potassium and water metabolism may play some part in the pathogenesis of congestive cardiac failure.

Gokhale and Godbole [20] observed a significant increase in serum lipid constituents and a decrease lipolytic enzyme activity in patients suffering from leprosy and tuberculosis. A close correlation between the increase in serum lipid concentration and a decrease in enzyme activity suggests a disturbance of fat metabolism in these two diseased conditions.

Biochemical investigations [21] carried out on 80 cases of influenza during the influenza epidemic in Bombay (1957, May) include: blood N.P.N. and urea nitrogen, blood sugar, serum calcium, blood sodium and potassium and serum albumin and globulin. None of these showed any deviation from the average normal figures.

Iyer [22] gave an account of paper chromatographic analyses of free amino acids in twenty normal and anaemic erythrocytes. In anaemia, the concentration of alanine, glutamine, glutamic acid, glycine and serine was found to be elevated while that of aspartic acid was low; glycine on the other hand was present in higher concentrations.

Serum Proteins: Paper electrophoresis has been the most popular and has been employed by most of the workers. Giri [29,30,31] developed a simple electrophoretic technique which has been designed as "agar electrophoresis". In this technique, the paper is replaced by agar gel layered on glass plate as the medium. The method is simple, quick and efficient in the resolution of protein components without adsorption. Furthermore, the technique affords the separation of a larger number of components in serum than those obtained by paper electrophoresis. The technique is elegant and is well suited for routine analysis of serum proteins in any clinical laboratory.

Kumar *et al.*[23] reported the results of analysis of serum proteins in 72 normal individuals by paper electrophoresis. The gamma globulin fraction was found to be significantly higher than the values reported by European and American workers. The values of total protein and of other fractions of serum proteins were in agreement with the reported values. The authors conclude that the increase in gamma globulin in Indians may be an index of greater immunity consequent to repeated exposure to infection.

Patel *et al*,[24] carried out analysis of serum proteins in 10 normal children and in 47 cases of malnutrition, by paper electrophoresis. The values of total protein and of albumin fraction were found to be lower than the normal in the marasmic malnutrition, but the lowest values were found in the oedema group. The *gamma* globulin was found to rise as albumin fall was associated with the development of oedema. It is suggested that the rise in *gamma* globulin and the severity of skin changes observed in the oedema group may be the manifestations of a severe biochemical abnormality in protein malnutrition.

The same authors [25] reported that in severe grade of protein malnutrition, there is a marked fall in serum albumin and a rise in *gamma* globulin and a tendency for the alpha 2 globulin showed a lower level. The authors believe the factors other than a decrease in albumin fraction are involved in the production of oedema.

Purandare *et al.*[26] carried out analysis of serum proteins by paper electrophoresis in patients of toxemia of pregnancy (23 cases of pre-eclampsia and 19 cases of eclampsia). The observed fall in albumin and rise in *alpha* 1, *alpha* 2, and *beta* globulin were significant. The failure of a rise in *alpha* 1 and *alpha* 2 globulin in eclamptic women and its possible connection with clotting and haemolytic mechanism are discussed.

Chatterjee and Banerjee [27] reported the results of separation of plasma proteins by paper electrophoresis in 22 normal healthy adults and in a group of 28 patients suffering from various diseases, such as diabetes, syphilis, acute enteritis, cirrhosis of the liver and lobar pneumonia. While a decrease in albumin fraction was found in all the cases studied, the other components varied differently in different diseases.

Agarwal *et al.*[28] reported the results of electrophoretic analysis of serum proteins and the liver function tests carried out in 43 cases of cirrhosis of the liver and in 72 normal Indian subjects. A rise in *gamma* globulin and a fall in albumin fraction of the plasma proteins was found to be associated with a decrease in liver efficiency as judged by liver function tests. An increase in thymol turbidity test and zinc sulphate turbidity test were found to be associated with a corresponding decrease in *alpha* and *beta* globulin fractions respectively.

Giri and co-workers [29] made a comparative study of the protein components obtained from normal healthy adults and from a number of pathological cases by agar electrophoresis. The results of the normal series indicate that the values of albumin as obtained by agar electrophoresis was consistently higher than the corresponding values obtained by moving boundary electrophoresis (M.E.) *Alpha* 1, *Alpha* 2 and *beta* globuln values obtained by A.E. were low as compared with the values obtained by M.E. A good agreement was observed in the values of *gamma* globulin as obtained by the two methods. Similar discrepancies in the values of protein components as obtained by the two methods were also observed in the pathological samples of sera. The significance of the observations is discussed. The authors offered explanation of the difference in the results obtained by A. E. and M. E.

Giri and Pillai[30] carried out investigations on the mobilities of haemoglobins of twelve different species of animals and their normal serum proteins. A considerable variation in the electrophoretic mobilities of the different animals was observed, the haemoglobin of the horse blood having the highest and that of the camel the lowest mobilities. The buffalo blood showed the presence of two haemoglobins, but the rat blood indicated the presence of one haemoglobin and two minor components. It is likely that the latter are some erythrocyte proteins characteristic of the species. The authors suggest that the possibility of the agar electrophoresis of haemoglobin being employed as a tool in medico-legal examination may be explored.

Giri[31] described a simple method of two-dimensional agar electrophoresis by which mucoproteins could be separated into well-defined zones. The mucoproteins can be obtained with fuchsin sulphate after periodate oxidation. The author presented typical patterns of normal human serum and cancer (chick) serum. The technique can be used for examination of the changes in mucoproteins in pathological samples of blood and also in urine.

Functional Tests: Benerjee *et al.*[32] conducted glucose tolerance test on 22 cholera patients. Most of the patients had initial hyperglycaemia. After intravenous injection of glucose, the blood sugar level rose, but two hours after the injection of glucose, the blood sugar came down to the initial level. The results indicate that in spite of initial hyperglycaemia the cholera patients can well utilise glucose. The authors recommended administration of glucose to cholera patients.

Ramanathan and Gopalan[33] studied the response of the blood sugar level to the administration of different cereals containing identical amount of carbohydrate in six normal subjects and in two cases of glycosuria. The rise in blood sugar level after the feeding of ragi was significantly higher than that following the feeding of rice. A similar difference was observed when rice starch and ragi starch were used in place of whole grain, but not when the two starches were subjected to enzyme hydrolysis. The possible significance of the above observations is discussed.

Srinivasan[34] reported that the glucose tolerance curve in both normal and hyperglycaemic subjects was significantly altered by ingesting together with or before the glucose certain types of protein and protein bearing foodstuffs. Casein, protein from tender dolichos, protein from black gram and the black gram itself were the most effective. Thur dhal, protein from mature dolichos, and a mixture of amino acids as in casein were less effective. The response to glucose tolerance curve varied with the individuals studied. The author suggests that the possibility of using glucose and an effective protein as a diet for hyperglycaemic patients should be kept in view.

Pathak and Srivastav [35] made a comparative study of choline esterase activity with other liver function tests in 20 normal adults, 34 cases of cirrhosis of the liver, 28 cases of viral hepatitis and in 12 cases of obstructive jaundice. The authors believe that the estimation of choline esterase activity (ChE) is an important test in the differentiation of jaundice of hepatocellular damage from obstructive pathology. In 15 early cases of cirrhosis of the liver, although the serum albumin was normal, the ChE activity was diminished, indicating that in parenchymatous damage of the liver, the synthesis of ChE was suppressed earlier than the synthesis of albumin. In obstructive jaundice the alkaline phosphatase level was found to be of diagnostic importance.

Das Gupta and Bawa [36] reported that the daily excretion of urinary 17-ketosteroids in 18 male and 5 female patients of infective hepatitis were very much lower than the normal values reported by other workers. No correlation was observed between the degree of dysfunction of liver as determined by various liver function tests and the excretion of urinary 17-ketosteroids. It is suggested that the low excretion of 17-ketosteroids in urine infective hepatitis may be due to impaired ability of the diseased liver to transform the precursor hormones to 17-ketosteroids.

Sachdev *et al.*[37] obtained low serum amylase values in the majority of the 76 patients suffering from cirrhosis of liver and in liver enlargement due to other causes. Low serum amylase values were also obtained in cases having low plasma proteins, particularly in children. The serum amylase values were not related in any way to the degree of liver damage. Cephalin cholesterol test was positive in majority of cases having low serum amylase values. It has been conjectured that this test can indicate pancreatic dysfunction at an early period.

Wahi[38] studied the role of adrenal cortex in experimental and human liver diseases. Adrenal cortical function was assessed in clinical cases of portal cirrhosis and in infective hepatitis. The liver damage was assessed by a number of liver function tests. In a preliminary report the authors presented evidence which suggest that there is adrenal deficiency in these disease states. The results of a study of the levels of urinary 17-ketosteroids in a number of the clinical cases studied are also suggestive of the presence of adrenal insufficiency.

Vasavada *et al.*[39] carried out haematological studies and liver function tests in 70 cases of hepatomegaly. The results did not show any set pattern of anaemia in any particular type of liver damage. Fifty per cent of the cases showed macrocytic anaemia irrespective of the type of liver injury. There was no correlation between the degree and type of anaemia and the extent of liver dysfunction.

Makhija *et al.*[40] reported the results of water dilution test and urea concentration test conducted on fifty medical students The results of water dilution test were found to correspond well with the results of urea concentration test.

Ahmed[41] performed water tolerance test on three healthy subjects and on ten non-febrile and non-oedematous patients varying in age from 20 to 40 years. After ingestion of one litre of water, the healthy and the diseased subjects eliminated on an average 908 ml. and 766 ml. of water respectively, the peak diuresis occurring at 60 minutes in both the groups. No correlation could be observed between the haemoglobin and total protein concentrations of the blood and the total output of urine after ingestion of water.

Sharma *et al.*[42] performed renal function tests on forty diabetic patients along with twenty normal persons. The results indicated that renal function was normal in diabetics below the age of 50 years, and with the disease of shorter duration. Gradual renal failure was observed in cases of mild and moderate diabetes of long duration in subjects above the age of 50 years. The impaired renal function correlated well with the duration of diabetes.

Banerjee and Ghosh [43] studied inulin and p-amino hippuric acid clearance in 16 patients suffering from diabetes and in 13 normal adults. The results indicate that renal clearance is comparable with the values obtained by Western workers. If the renal clearance in diabetic patients were expressed in terms of the normal body surface of 1.57 sq.m. (Indian), the glomerular filtration rate (inulin clearance) was significantly higher than the normals although the renal plasma flow (p-amino hippuric acid clearance) was not altered.

Urinary excretions: Pain and Banerjee [44] reported that the average daily excretion of total N and urea N in normal Bengalees was 7.8 and 4.28 g. respectively. Patients with cirrhosis of the liver excreted more of amino acid N and ammonia N and less of other nitrogenous constituents. Creatine was also present in urine. Patients with sub-acute nephritis excreted more of amino acid N, while other nitrogeneous constituents were greatly diminished. In hypertensive patients all the nitrogenous constituents of urine were low probably due to renal failure,

Bose *et al.*[45] reported that the basal urinary excretion of riboflavin was increased during menstrual period in women. The percentage excretion of a test dose of 2 mg. of riboflavin was found to increase from pre-menstrual to post menstrual period. The authors suggest that inhibition of flavoprotein enzyme by menotoxin present in menstruating women might spare riboflavin for urinary excretion.

Sarin and Bhargava [46] reported a case of alcaptonuria with ochronosis associated with pathognomic feature of calcification of intravertebral discs. The colour of the freshly passed urine was normal but after standing it turned black. The usual tests for homogentisic acid were positive. Benedict's regent turned black, which, on standing, gave a yellow precipitate. It is suggested that this rare case of abnormal metabolism is liable to be mistaken for diabetes.

Miscellaneous: Mukherjee *et al.*[47] reported that diabetic rats having blood sugar below 300 mg. per cent within seven days of alloxan administration show a tendency to spontaneous recovery, while those rats whose blood sugar reaches 300 mg. per cent or above within 5 days after alloxan administration become permanently diabetic. The results of different types of treatment show that combination of vitamin K and estrogen is the most effective and the combination of vitamin E and estrogen is the least effective. When administered separately estrogen was found to be more effective than either vitamin K or vitamin E.

Chattopadhya and Banerjee[48] carried out estimations of urinary excretion of different metabolites of tryptophan in 24 hours urine sample of normally fed, normally and alloxan-diabetic rabbits before and after the feeding of 1 g. of DL-tryptophan. The results suggest that in alloxan diabetic rabbits the conversion of tryptophan to nicotinic acid is lowered. Injection of insulin was found to restore the reduced conversion of tryptophan to nicotinic acid in diabetic rabbits fed tryptophan.

Krishna and Chakravarti[49] carried out fractionation of serum proteins by paper electrophoresis in atherosclerotic rabbits at different periods of cholesterol feeding. A relative hyperglobulinaemia of *alpha*, *beta* and *gamma* fractions with a reversal of A/G ratio was observed at the termination of the experiment. The *alpha* 1 globulin showed an initial rise followed by a marked fall below the normal level at twelve weeks. Maximum changes in serum proteins occurred at the eighth week producing critical physico-chemical alterations in the system which may precipitate the atheromatous change.

Chakravarti *et al.*[50] reported the results on the changes in serum protein and lipoproteins estimated by paper electrophoresis in rabbits fed on coconut oil, groundnut oil and cholesterol.

Chakravarti *et al.*[50] studied the therapeutic effect of ascorbic acid and vitamin B_{12} on experimental atherosclerotic rabbits. The results suggest that vitamin B_{12} alone and in combination with ascrobic acid produces a greater degree of inhibition of atheroma than ascorbic acid alone. Vitamin B_{12} was found to produce a marked increase in free cholesterol and free / total cholesterol ratio in serum.

Krishna *et al.*[51] reported the results on the changes in serum protein and lipoproteins estimated by paper electrophoresis in rabbits fed on coconut oil, groundnut oil and cholesterol alone and in combination with each of the oils separately. The results demonstrate that a marked lowering of the ratio of *alpha*/O+*beta* lipoproteins is related to atheroma formation.

Gopalan and Ramanathan [52] performed water load tests on three comparable groups of monkeys receiving normal diet, high calorie low protein diet and low-calorie low protein diet. The response to these tests was more impaired in animals on high-calorie low-protein diet than those on low-calorie low-protein diets. No correlation was found between the duration of feeding of the different diets and the response to these tests.

Sarcar and Banerjee [53] performed glucose tolerance test on six rhesus monkeys both before and two to three months after the withdrawal of ascorbic acid supplement. At the end of three months when the monkeys developed severe scurvy, the blood sugar level was found to be higher in all the samples tested after administration of glucose. No change was observed in the fasting blood sugar when monkeys developed scurvy. It is suggested that vitamin C is essential for the normal utilization of carbohydrates in monkeys.

De and Dikshit [54] studied the influence of dietary phosphorus in rats on the utilisation of carotene and its ultimate storage as vitamin A. The authors conclude that dietary phosphorus did not influence the utilisation of carotene.

Mehrotra *et al.*[55] reported that desoxycorticosterone acetate produces significant increase in the volume of ascitic fluid in induced carbon tetrachloride cirrhosis in albino rats. The findings show that the retention of sodium appears to influence the volume of the fluid which accumulates in the peritoneal cavity of these animals. The authors suggest that whatever be the role of sodium-retaining adrenal cortical hormone in the development of ascites, the hormone appears to operate at a stage when the liver is grossly damaged and when fibrosis is marked.

Sachdev [56] studied the preventive action of anti-fatty liver factor of the pancreas and of lipocaic on ethionine-induced fatty livers in 25 female fasted albino rats. Anti-liver factor of pancreas and lipocaic failed to prevent the accumulation of fat when administered simultaneously with ethionine, while methionine could prevent accumulation of fat under similar conditions.

Joshi and coworkers[57] reported that oral administration of a single dose of vitamin D to rachitic dogs increased the citrogenase activity, citric acid and total P content of cartilage. Vitamin D administration to rachitic dogs also brought about a concomitant rise in serum calcium, inorganic P and citric acid level of serum. The results of the experiments point to the close association between the citric acid metabolism and the process of calcification.

Venkateswarlu and Narayanarao[58] carried out a series of experiments on guinea-pigs to determine the need for more than normal requirement of vitamin C in fluorine intoxication. The results have not yielded any biochemical evidence to support the view that vitamin C therapy offers much hope against fluorosis.

Thangamani and Sarma[59] studied the role of pantothenic acid in the biosynthesis of ascorbic acid in the rat. It is suggested that glucose-cyclo-acetoacetate may act as a precursor of ascorbic acid by first being converted to glucuronic acid. Pantothenic acid in the form of coenzyme A may be necessary for further conversion of glucuronic acid to ascorbic acid.

Chatterjee *et al.*[60] studied the enzymatic synthesis of ascorbic acid in animal tissues. The enzyme concentrate for the study has been obtained by ammonium sulphate fractionation of goat liver extract. D-glucuronolactone was used as substrate. The fact that the enzyme-system concerned in this biosynthesis is inhibited by p-chloromercuric benzoate and $HgCl_2$ indicates that the thiol group may be involved in this synthesis.

REFERENCES

1 Banerjee, S. & Sen, R. (1957), Indian J. Med. Res. **45**, 33.

2 Sastri, R. & Indravati, D. (1957), *Ibid.*, **45**, 447.

3 Banerjee, S. & Biswas, D. K. (1957), *Ibid.*, **45**, 411.

4 Jayalakshmi, V. T., Ramanathan, M. K. & Gopalan, C. (1957), *Ibid.*, **45**, 431.

5 Rao, B. S. N. & Gopalan, C. (1957), *Ibid.*, **45**, 85.

6 Sathe, V. R., Talageri, V. R., Khanolkar, V. R., & Panse, T. B. (1957), *Ibid.*, **45**, 401.

7 Konar, N. R. (1957), J. Indian Med. Assoc., **28**, 472.

8 Bhatia, A. L., Ghai, S. N. & Dudani, A. T. (1957), Indian J. Med. Res., **45**, 299.

9 Basu, B., Bhettacharjee, K. L. & Bose, A. (1957), J. Indian Med. Assoc.., **28**, 469.

10 Nath, H. P., Gupta, K. K, & Iyer, P. V. K. (1957), Indian J. Med. Res., **45**, 217.

11 Gopalan, C. & Ramanathan, K. S. (1957), *Ibid.*, **45**, 593.

12 Jayalakshmi, V. T., Ramanathan, M. K. & Gopalan, C, (1957), *Ibid.*, **45**, 605.

13 Dixit, C. H., Mody, B. N., Jhala, H. I., Parekh, J. G. & Ramasarma, G. B. (1957), Indian J. Med. Sci., **11**, 145.

14 Dixit, C. H., Mody, B. N., Jhala, H. I., Parekh, J. G. & Ramasarma (1957), *Ibid.*, **11**, 147.

15 Narayanan, M. S., Shenoy & Ramasarma, G. B. (1957), *Ibid*, 163.

16 Chatterjee J, B., Ghosh, S. K., Roy, R. N., Basu, A. K. & Banerjee, D. K. (1957), *Ibid.*, **11**, 563.

17 Ghosh, P. K. (1957), J. Indian Med. Assoc., **29**, 85.

18 Nath, H. K. & Chakrabarti, (1957), Indian J. Med. Res., **45**, 359.

19 Udwadia, F. E., Datey, K. K., Ramamoorthy & Sheth, U. K. (1957), J. Post Graduate Medicine, **111**, 199.

20 Gokhale, S. K. & Godbole, S. H. (1957), Indian J. Med. Res., **45**, 327.

21 Report of the Influenza Research Committee (1957), Indian J. Med, Sci., **11**, 599.

22 Iyer, G. Y. N. (1957), Indian J. Med. Res., **45**, 213.

23 Kumar, A., Agarwal, K. L., Kumar, S. & Mangalik, V. S. (1957), Indian J. Med, Sci., **11**, 398.

24 Patel, B. D., Gaitonde, B. B, Malati, A., Jadhav & Rao. G. S. (1957), Indian J. Child Health, **6**, 289.

25 Patel, B. D, Malati, A., Jadhav, Gaitonde, B. B. & Rao, G. S. (1957), Jour, J. J, Group of Hospitals, **3**, 40.

26 Purandare, B. N., Shanta, & Kavan, S. (1957), J. Post Graduate Medicine, **111**, 215.

27 Chatterjee, K. and Banerjee, S. (1957), Indian J. Physiol. and Pharmacol, **1**, 185.

28 Agarwal, K. L., Kumar, A. Kumar, S. & Mangalik, V. S. (1957), J. Indian Med. Assoc., **29**, 387.

29 Giri, K. V., Nath, R. & Srikantiah H. (1957), J. Indian Inst. Sci., **39**, 224.

30 Giri, K. V. & Pillai, N. C. (1967), *Ibid.*, **39**, 248,

31 Giri, K. V. (1957), Nature, **179**, 632.

32 Banerjee, S., Bhaduri, J. N. & Sarcar, A. K. (1957), Indian J. Med., Res., **45**, 9.

33 Ramanathan, M. K. & Gopalan, C. (1957), *Ibid*, **45**, 255.

34 Srinivasan, M. (1957), Lancet, August 17, 317.

35 Pathak, M. A. & Shrivastav, J. B. (1957), Indian J. Med. Sci., **11**, 588.

36 Das Gupta, S. K. and Bawa, Y. S. (1957), Indian J. Med. Res., **45**, 41,

37 Sachdev, S., Sachdev, J. C, & Singh, R. C. (1957), J. Indian Med. Assoc., **28**, 304.

38 Wahi, P. N., Ramachandran & Navani, H. (1957), *Ibid.*, **28**, 133.

39 Vasavada, P.S., Arora, M.M. & Mukherjee, D.P. (1957), *Ibid.*, **28**, 342,

40 Makhija, J. R., Pai, M. L. & Dixit, Y. B. (1957), Jour. J. J. Group of Hospitals, **2**, 31.

41 Ahmed, A. (1957), J. Indian Med. Assoc., **28**, 85.

42 Sharma, R. S., Singh, G. & Singh, M. M. (1957), Indian J. Med. Assoc., 339.

43 Banerjee, S., Ghosh, H. (1957), Indian J. Physiol. Pharmacol. **1**, 126.

44 Pain. S. K. & Banerjee, S. (1957), Indian J. Med. Res., **45**, 35.

45 Bose, B. C., Gupta, S. S. & Pathak, T. C. (1957], J. Indian Med Assoc., **29**, 96.

46 Sarin, L. R. & Bhargava, R. K. (1957), *Ibid.*, **28**, 481.

47 Mukherjee, S. K., De, U. N. & Mukherji, B. (1957), Indian J. Med. Res., **45**, 23.

48 Chattopadhyay, D. P. & Banerjee S. (1957), Indian J. Physiol. & Pharmacol., **1**, 247.

49 Krishna, B. & Chakravarti, R.N. (1957), Indian J. Med. Res., **45**, 243.

50 Chakravarti, R. N., De. U. N. and Mukherji, B. (1957), *Ibid.*, **45**, 315.

51 Krishna, B., Chakravarti, R.N. & Mukherji, B. (1957), *Ibid.*, **45**, 549.

52 Gopalan, C, & Ramanathan, K. S. (1957), *Ibid.*, **45**, 65,

53 Sarcar, A. K. & Banerjee S, (1957), Indian J. Physiol. & Pharmacol. **1**. 25.

54 De, N. K. & Dikshit, P. K. (1957), Indian J. Med. Res., **45**, 71.

55 Mehrotra, R. M. L., Mangalik, V. S. & Nayak, N. C. (1957), *Ibid*. **45**, 183.

56 Sachdev, J. C. (1957), *Ibid.*, **45**, 227.

57 Joshi, J. G., Dikshit, P. K. & Patwardhan, V. N. (1957), *Ibid.*, **45**, 439.

58 Venkateswarlu, P. & Narayanarao, D. (1957), *Ibid.*, **45**, 387.

59 Thangamani, A. & Sarma, P. S. (1957), Curr. Sci., **XXVI**, 72.

60 Chatterjee, I. B., Ghosh, N. C., Ghosh, J. J., Roy, R. N. & Guha. B, C. (1957), Science and Culture, **23**, 50.

DAIRY SCIENCE

JAMES N. WARNER
Department of Dairy Technology
Allahabad Agricultural Institute, Allahabad

During 1957 progress continued to be made in implementing the dairy portions of the Second Five Year Plan ; the Central Dairy College was opened at the National Dairy Research Institute ; and a number of persons returned from periods of training or observation abroad.

Subrahmanyan *et al.*[1] assembled some data on our production and imports of milk and milk products. Khurody[2] compared local currency and sterling prices of milk in several countries, and concluded that cheaper milk in India was essential to increased consumption. Rawat[3] suggested government subsidies to give producers adequate prices for their milk. Thapur[4] encouraged a good market, proper manufacturing techniques, and specialized dairy farms as means of developing our milk supply.

Dairying in this country was discussed for American readers by Shahani.[5] Singh[6] discussed dairying in Sweden ; Singh,[7] De,[8] and Henriksen[9] reported on dairying and dairy trade in Denmark ; and Sen[10] gave some information on dairying in Switzerland.

The Milk Marketing Board in England and Wales was discussed by Singh ;[11] Godbole[12] described the milk board in New Zealand and the control it exercises. Rawat[3] stated that retail milk prices in India might be regulated through milk marketing boards. Kannan[13] made some comparisons of the marketing and public health control of milk in New York City and Delhi.

Several amendments to the Prevention of Food Adulteration Act affecting the dairy industry were made, effective from the 14th of July and from the 20th of November 1956.[14] Amendments to the Creamery Butter (Grading and Marketing) Rules, 1941, were discussed.[15] The Medical and Health Officer, Delhi Municipal Committee, issued a bulletin entitled " Food Frauds and

How to Fight Them," dealing in part with milk and milk products.[16] Milk foods were included in the Industries (Development and Regulation) Act, 1951, with effect from the 1st of March 1957.[17] Two Committees were set up by the Indian Standards Institution, according to Modawal,[18] to deal with dairy utensils and dairy laboratory apparatus.

Iya and Dastur [19] drew attention to the New Dairy Science College, at the National Dairy Research Institute, to which the first batch of 20 students was admitted in July 1957. Khurody [20] raised several questions and made certain suggestions in regard to the improvement of dairy training courses on the lines sponsored in Denmark in 1956 by F.A.O.

The Dairying Committee of the Tenth Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India considered questions, such as, increasing the production of milk in rural and forest areas, transporting milk in rural areas, standards and quality control, marketing of toned milk, and the possible utility of a Central Dairy Information Bureau.[21] The same Committee of the Eleventh Meeting of the Wing discussed: training additional personnel, prohibiting the sale of unpasteurized milk in certain cities, and the marketing of sterilized milk.[22] In a small book, Mudaliar [23] discussed the secretion and properties of milk, bacteria and milk, and the manufacture of certain milk products. Khurody [24] suggested the need of studying the historical background of Indian Dairying.

The proposed Delhi Milk Scheme [25] and the development of dairying in Bombay [26] were both briefly discussed. Something of the work of Louis Pasteur which led to the process of pasteurization is given by Bhat and Shroff.[27]

DAIRY HUSBANDRY

Breeds and Breeding

Kohli and Suri [28] reported that the length of 797 gestations in Hariana cows was 290.71 ± 0.9 days and listed several factors correlated with this value; the same authors [29] reported that male calves were heavier at birth than female calves. Kumaran [30] found that the average production of 63 lactations completed in 1952 by Tharparkar cows at Karnal was 5,503 pounds in 289 days. Agarwala[31] reported a genetic gain of 0.22 pounds butterfat per annum between 1936 and 1951, or about 0.1 per cent of the average first lactation butterfat production, in Murrah buffaloes at the Allahabad Agricultural Institute.

Feeds and Feeding

Venkayya and Anantakrishnan[32] showed a significant correlation between age at first calving and the yield during the first lactation and between age at first calving and the length of the first lactation in Red Sindhi, Gir, and Ayreshire X Sindhi crossbred cows. These authors[33] also reported that the records of 58 Murrah buffaloes showed that the averages of age at first calving were 44.3 months, of first lactation yield 3,253 pounds, of first lactation length 327 days, and of first calving interval length 490 days, with significant correlation and regression co-efficients between age at first calving and first lactation milk yield, and between age at first calving and first lactation length, but that those between age at first calving and first calving interval length were insignificant.

Sampat *et al.*[34] reported only a temporary increase in the vitamin A content of milk fat, especially between 18 and 24 hours after feeding, of cows fed supplements of 400,000 to 800,000 I.U. once weekly; that a supplement of 1.0 million I.U. increased the milk-fat vitamin A content from 30 to 160-190, while a supplement of 1·4 million I.U. increased the milk-fat vitamin content from 30 to 240-300 I.U./g. Narayanan *et al.*[35] reported that the rate of secretion of tocopherol, vitamin A, and carotene in milk depended upon the tocopherol and carotene content of the ration.

Rao[36] discussed the importance of proper feeding and management in reducing death losses of buffalo calves.

Mannar *et al.*[37] found that of the four quarters of the udders of four Red Sindhi and eight crossbred cows, the right hind quarter gave the most milk, but that there was no significant difference in the butterfat production of the different quarters of the same udder.

MILK

Physical and Chemical Properties

Dastur and Rao[38] reported on the pH and buffer values of colostrum and milk of the Gir and Red Sindhi zebus and the Murrah buffaloes; they found a wide range of variation of the pH, and a buffer value of buffalo milk greater in the acid range, less in the alkaline range, than that of zebu milk. Rao and Dastur[39] stated that the pH of milk increased as the lactation progressed; that sterilization increased the pH of milk; and that pasteurization, boiling, skimming, and dilution with water decreased the pH.

Limdi and Bhatt[40] gave a table of factors for correcting the lactometer readings made at 60°F. for variations in fat per cent in buffalo milk, based on Richmond's formula. Ahuja and Gautam[41] found 4.62±0.16% fat in 996 morning samples and 5.11±0.33% fat in 993 evening samples of bulked milk from a heard of 45 Hariana cows; the fat was highest in October to January, lowest in May to June; rainfall depressed the fat content of milk.

Kulkarni and Dole[42] suggested that the viscosity and its relation to the fat and S. N. F. of milk might be useful in detecting adulteration; and that the size of the fat globules, rather than the number present, had some effect on milk viscosity. Khurody[43] gave a brief report on the chemical quality of market milk in Madras between 1950 and 1955, and made certain suggestions as to how to reduce adulteration. Paul[44] expressed the opinion that two kinds of milk, that is cow and buffalo milk, and low standards interfered with the prevention of adulteration of milk. Dastur[45] discussed the fat and S.N.F. standards for milk in the different States of India.

Kehar *et al.*[46] gave the chemical constants of ghee prepared from milk from eight breeds of zebu and one breed of buffalo on twelve farms in different parts of the country. Sampath and Anantakrishnan[47] found no significant correlation between the Reichert and iodine values in the fat of 400 samples of zebu, buffalo, and mixed milk; and although monthly variations and the difference in the Reichert values of zebu and buffalo milks were significant, the differences in iodine values of the two milks were not significant. Seth and Aggarwal[48] reported that red chillies, cloves, and betel leaves are sources of antioxidants for edible fats.

Sampath *et al.*[49] claimed that synthetic vitamin A was more stable in ghee than in sesame oil at a concentration of 50 I.U./g., whereas at 150 I.U./g. concentration there was little difference; and that this stability was affected neither by butylhydroxy anisole nor ethyl gallate when incorporated into the fats. Sampath and Anantakrishnan,[50] while studying the relative heat stability of synthetic vitamin A acetate in ghee, vanaspati, and oils, found that peroxide development was rapid, except in coconut oil, during heating; that both butylhydroxy anisole and ethyl gallate reduced peroxide development and loss of vitamin A in fortified ghee, but not in vanaspati and oils, except in coconut oil; and that added vitamin A was most stable in ghee in the presence of an antioxidant. Hattiangadi and Kanga [51] found that losses of vitamin A from both ghee and vanaspati were greatest in shallow frying, less in deep frying and least in simmering; and that the losses in shallow frying and deep frying were greater in ghee than in vanaspati. Kehar *et al.*[52] while studying the effect of heat on the various chemical constants of ghee, likewise found that vitamin A destruction was generally greater in ghee than in vanaspati; in the same paper, these authors also discussed the difficulties of detecting the adulteration of ghee with vanaspati or lard.

Baliga and Basu [53] found that the phospholipid contents of six samples of cream increased with the fat content, with values ranging from 0.26 to 0.55% in the fat; that *desi* butter contained much less phospholipid than creamery butter; that the phospholipid content of ghee made from *desi* butter was smaller than that made from creamery butter; and that the phospholipid content of *desi* buttermilk was independent of its fat content.

Apte and Sohonie [54] reported that a trypsin-inhibitor found in double bean markedly affected the rate of tryptic hydrolysis of proteins in skim milk. Puri *et al.*[55] standardized a sensitive colorimetric method for determining the heat of flocculation of milk at the iso-electric point of casein, and measured the heat of flocculation of milk from different species and individuals; they found that this value was a function of the casein content of the milk, and that fat had no effect on it; and they found the degree of dispersion of casein almost identical in all types of milk studied. Boman and Dalal [56] reported a riboflavin content of 1.00 to 1.66 p.p.m of curds made from buffalo milk as determined by microbiological assay with *L. casei.*

Analysis

Vachha *et al.*[57] studied autoxidation of buffalo and zebu ghee at 98°C. and found zebu ghee absorbed oxygen less rapidly and was more resistant to oxidation than buffalo ghee. Tawde and Magar [58] employed three techniques, viz. the low temperature crystallization or urea fractionation, the methylester fractionation, and the alkali isomerization of the steam distillate, to find that the saturated fatty acid content of three varieties of Belgaum ghee was 63 to 64% and the unsaturated fatty acid content was 35 to 36%. Subbaram and Mahadevan [59] used partition chromotography for the quantitative separation and estimation of the isooleic acid fraction in zebu butter fat.

Dane and Om Prakash [60] found that an electrical apparatus made in the country and a modification of it were both unsuitable substitutes for Junge's apparatus for determining the melting point of ghee as required in the phytosterol acetate test. Narayanan and Kartha [61] stated that zebu ghee contained from 3.0 to 6.3%, buffalo ghee about 6.0%, and vegetable fats and oils only 1.0 to 2.0% of solid oleic acid. Loss during storage was reported by Kehar *et al.*[62] to be responsible for potencies of 1.44 p.p.m. of vitamin A in the summer and 1.26 p.p.m. in winter in the 58 samples of bazar ghee examined; these authors also stated that the vitamin A potency of the ghee mentioned by other workers [46] was 7.06 p.p.m. in buffalo ghee and 10.51 p.p.m. in zebu ghee, with the buffalo ghee containing no carotene.

Tawde and Magar [63] suggested that urea fractionation might be useful in detecting the adulteration of ghee with vanaspati. By measuring the turbidity temperature of the mixture, Desikachar *et al.*[64] was able to detect the adulteration of ghee with 20% vanaspati, using benzyl alcohol-glycerine as a solvent; they stated that while the turbidity temperature of ghee varied widely, that of vanaspati was 20 to 25°C higher. Venkatachalam and

Sundaram[65] claimed that by using 50% ethyl alcohol with water, in place of water, in the Holde's test, they could detect the presence of as little as one per cent or less of the thinnest mineral oil in ghee.

As little as 0.25% of cane sugar added to milk could be detected by use of the Seliwanoff Reagent (resorcin and HCl), according to Mitra and Roy.[66] An electric test invented in U.S.A. was reported[67] useful for detecting watered milk by the "measurement of indirect conductivity in moisture laden materials."

Nutritional Studies

Tawde and Magar[68] found that in controlled experiments the growth rates of rats on a diet including 20% rancid ghee were lower than those fed a similar amount of fresh ghee; that protein metabolism was less efficient in the rancid fat group, although fat metabolism was normal in both groups. The digestibility coefficients of zebu and buffalo ghees, lard, seven brands of vanaspati, and several vegetable oils were shown by Kehar *et al.*[69] to differ only slightly in rat feeding experiments. Something of the growth promoting qualities of zebu ghee as compared to vanaspati appeared in rats on the Bengali diet;[70] mortality in rats fed from weaning to 25 weeks of age on the "Bengali" diet plus 5% vanaspati varied from 42 to 92%, whereas the mortality rate of similar rats fed for the same period on the "Bengali" diet plus 5% zebu ghee was only 8%. The authors attribute this difference in mortality primarily to the difference in vitamin A intake in the two groups of rats, namely about 1 I.U. per day per rat in the group getting vanaspati as compared to 6 to 8 I.U. per day per rat in the group getting zebu ghee, because they showed that supplementing Bengali diet with vitamins masked the effect of the ghee. They added, however, that even with a richer "North India" diet, the value of added ghee could be demonstrated. Kehar *et al.*[71] stated that a diet sub-optimal for vitamin A and containing ghee or vanaspati fed to rats over three generations showed that these animals failed to reproduce unless the basal diet was supplemented with skim milk and greens daily, but the rats on either zebu ghee or buffalo ghee gained more rapidly than those on vanaspati; the difference between the fats did not appear if the rats were fed adequately. Ghee was more effective, stated Kehar *et al.*[72] in causing vitamin A storage in the liver than was any of the other dietary fats supplied to rats on a basal diet containing 10 I.U. carotene per diem supplemented with greens to give a daily intake of 250 to 300 I.U. carotene; the presence of refined fats, vanaspati, and ghee in the diet increased the digestibility of the carotene. Kehar *et al.*[73] reported that the addition of fat to a diet sub-optimal for vitamin A increased the digestibility and biological value of protein; zebu ghee increased digestibility by 36% and the biological value by 62%. The addition of B-vitamins did not change the protein digestibility, but increased the biological value 13 to 14% if groundnut oil or hydrogenated groundnut oil was the dietary fat. In another paper, Kehar *et al.*[74] reported that feeding 0.3, 5, and 8 micro grams of thiamine per rat per diem and various dietary fats, after depleting them of thiamine, produced the greatest gains in weight in those fed ghee, except at the 8 micro gram level when those getting crude groundnut oil excelled; also riboflavin-deficient rats showed the best growth with zebu ghee, except at high intake levels of around 8 micro grams per diem. Kehar *et al.*[75] reported that zebu ghee caused 45 per cent of the dietary calcium to be retained as compared to only 22.6 to 40.7 per cent with other fats, with vanaspati the retention of calcium being less efficient than vegetable oils. Phosphorus absorption was less with oils, lard, or vanaspati than with ghee; with zebu ghee 57 % of the dietary phosphorus was retained.

Dalal [76] briefly discussed the nutritive value of milk and compared it with certain other foods. Colbourne and Sowah [77] found that in 55 infants a milk diet for the first six months of life did not protect them completely against malaria. Observations of gastric response, digestion, and evacuation time by fractional gastric analysis and fluoroscopy in healthy subjects given various foods, including milk and milk products, were tabulated by Pathak and Pai.[78] Lal and Bose [79] reported that a group of 337 boys fed one ounce of dried skim milk, reconstituted to eight ounces, daily for about a year showed significantly greater gains in weight and a lower incidence of nutritional defects than a similar group of 359 boys receiving no dried skim milk during the same period. Sulphaguanidine did not inhibit the production of thiamine from curds by coliform bacteria in the intestines of rats and men, according to Baliga *et al.*[80]

Bacteriology

Srinivasan *et al.*[81] reported that the lipolytic activity of certain moulds seemed slightly inhibited by yeasts when pure cultures of the organisms were inoculated into both *desi* and creamery butter which had been sterilized by autoclaving. Subrahmanyan and co-workers [82] studied low strength aqueous solutions of several common food spices in low concentrations as bactericides ; none of the spices studied inhibited L. *casei* ; in fact aniseed and *Ajowan* stimulated the growth of this organism.

Nambudripad *et al.*[83] stated that the folic and folinic acid activity in milk during the production of *dahi* was increased by common acid producing organisms, and that the nutritive value of *dahi* would be increased if *S. lactis* and *S. theromophilus* were used in its production. Gonsalves *et al.*[84] ascertained the amino acid requirements of several lactic acid species isolated from *dahi*. From similar studies by Nambudripad *et al.*[85] where the nutritive requirements of 57 lactic acid bacteria cultures were studied, it was reported that the streptococci required at least pantothenic acid, nicotinic acid, and biotin; that most of the lactobacilli required riboflavin, pantothenic acid, nicotinic acid, and biotin ; and that the requirements of other vitamins of the B-complex were variable or negative.

Iyengar *et al.*[86] reported that the time and temperature of heat treatment, the density of the cell population, the age of the culture, and the composition and pH of the medium exerted significant influences on the heat resistance of four species of streptococci found in milk. Laxminarayana *et al.*[87] studied the influence of pH and composition of the medium on the reduction of tetrazolium in milk by lactic acid bacteria.

MILK PRODUCTS

Sampath *et al.*[88] studied the relative stability of synthetic vitamin A in ghee, oils, and butterfat during storage, with and without the addition of one or two antioxidants; no influence of the two antioxidants on the stability of the vitamin A was observed. Ray [89] discussed in some detail the making of ghee and its industrial possibilities. Ghee quality, with special reference to ghee from Coimbatore and Salem districts of Madras State, was discussed by Sriraman.[90]

The chemical composition of the more expensive grades of ice cream in India compared well with that of ice cream in England or America, according to Govil *et al.*[91] Rawat [92] discussed briefly the food value, classification, composition, manufacture, and storing of ice cream.

Sundararajan and Sarma [93] gave an account of the preparation of dephosphorylated casein at pH 6.0 by the addition of a phosphoprotein phosphatase extracted from ox spleen; they also did some work on the determination of the amino acid content of this casein.

According to Dastur and Rao,[38] the pH values of the following milks were: crossbred 6.64, Gir 6.64, Red Sindhi 6.60, and Murrah 6.74. Khurody [94] gave an account of the progress made in the preparation of toned milk.

Ray [95] discussed in some detail the possibilities of condensed and dried milk production. Several aspects of the production of dried milk were mentioned, such as some of the changes taking place during the process; [96] the industrial control of dried milk quality, by Falkenhahn; [97] the spray and roll process, by Chandrasekhara *et al.*[98] who also outlined the manufacture of baby food and gave the gross composition of several brands of this food imported into the country; and the manufacture of spray dried milk, by Galsman and Hansan.[99] Chakravarti [100] reported on the effects of adding lactose, sucrose, and sodium caseinate on the protein stability and wettability of dried milk and on the dialysis of the powder; he also mentioned the effect of two specific preheating exposures and the additions of calcium chloride.

The National Research Development Corporation of India made possible the experimental production of about two tons of infant food from buffalo milk at Anand.[101] Subrahmanyan *et al.*[102,103] outlined briefly the process of manufacture of infant foods, invalid foods, and other milk products, from buffalo milk. A series of papers, by workers at the Central Food Technological Research Institute, discussed in considerable detail the use of buffalo milk for making infant food: Chandrasekhara *et al.*[104] reported on the effect of different treatments of buffalo milk on its curd tension; they [105] discussed the standardisation of conditions for the preparation of infant food from buffalo milk; these workers [106] reported experiments on the shelf life of infant food made from buffalo milk; and they [107] reported on the results of infant feeding trials with the infant food made from buffalo milk.

DAIRY PLANT AND MANAGEMENT

The costs of processing, bottling, transporting, and distributing milk at Aarey were given by Khurody for the period of April 1954 to March 1955 [108] and for the following year.[109] Salpekar [110] stated that milk production costs at Aarey fell from an average of 12.50 annas per seer for four years to 10.85 annas in 1954-55.

Panse [111] gave details of the organization and results of the pilot survey for estimating the cost of milk production in Delhi State; he stated that gross costs were 8.65 annas per seer in urban areas and 7.64 annas in rural areas, with little difference in net costs between herds of different sizes where this could be ascertained.

DAIRY MACHINERY AND EQUIPMENT

The use in Switzerland of a plastic pipe line about five miles long and descending 1,500 feet to bring milk from Alpine pastures to a processing plant was mentioned at least twice.[112,113] Jensen discussed Danish dairy machinery.[114] The layout of the equipment at Aarey was described by Khurody.[108]

Medora and Variava [115] reported that butter made from vacreated cream at Anand was better in flavour, keeping quality, and consistency than that made of cream pasteurized by either the flash or the holding methods; the vacreator was unable to remove smoky and cheesy flavours.

REFERENCES

1 Subrahmanyan, V., Chandrasekhar, M. R., Bhatia, D. S. and Swaminathan, M. (1957), Food Sci. **6** (3), 52.

2 Khurody, D. N. (1956), Int. Dairy Congr., **1** (2), 605.

3 Rawat, R. S. (1957), Indian Dairyman, **9** (8), 310.

4 Thapur, P. N. (1957), *Ibid.*, **9** (5), 163.

5 Shahani, K. M. (1957), J. Dairy Sci. **40** (7), 867.

6 Singh, S, G. (1957), Indian Dairyman, **9** (8), 296.

7 Singh, S. G. (1957), *Ibid.*, **9** (11), 407 ; and **9** (12), 453.

8 De, S. (1957), *Ibid.*, **9** (4), 151.

9 Henriksen, P. K. (1957), *Ibid.*, **9** (1), 19,

10 Sen, J. N. (1957), *Ibid.*, **9** (10), 371.

11 Singh, S G. (1957), *Ibid.*, **9** (9), 343.

12 Godbole, G S. (1957), *Ibid.*, **9** (9), 321 ; **9** (10), 375 ; and **9** (11), 417.

13 Kanan, A. (1957), *Ibid.*, **9** (7), 271.

14 Gupta, J. P. (1957), A Commentary on the Prevention of Food Adulteration Act, 1954. Hindustan Law Publishing Co., Meerut.

15 Indian Dairyman (1957), **9** (6), 211.

16 *Ibid.* (1957), **9** (11), 392.

17 Indian Food Packer (1957), **11** (3), 22,

18 Modawal, C. N. (1957), Indian Dairyman, **9** (1), 46.

19 Iya, K. K. and Dastur, N. N. (1957), *Ibid.*, **9** (6), 217.

20 Khurody, D. N. (1957), *Ibid.*, **9** (1), 15.

21 Proceedings of the Tenth Meeting of the Animal Husbandry Wing, Board of Agriculture of the Government of India (1956), Manager of Publications, Delhi.

22 Proceedings of the Eleventh Meeting of the Animal Husbandry Wing, Board of Agriculture of the Government of India (1956), Manager of Publications, Delhi.

23 Mudaliar, V. T. S, (1956), A Handbook of Animal Husbandry and Dairying. Bangalore Printing and Publishing Co., Bangalore.

24 Khurody, D. N. (1957), Indian Dairyman, **9** (7), 268.

25 Indian Dairyman (1957), **9** (5), 159.

26 *Ibid.* (1957), **9** (3), 89.

27 Bhat, J. V. and Shroff, Miss L. T. (1957), Indian Dairyman, **9** (2), 61.

28 Kohli, M. L. and Suri, K. R. (1957), Indian J. Vety. Sci. and Animal Husbandry, **27** (1), 23.

29 Kohli, M. L. and Suri, K. R, (1957), *Ibid.*, **27** (1), 33.

30 Kumaran, J. D. S. (1956), J. Vety. Res., **1** (1), 12.

31 Agarwala, O. P. (1956), Indian J. Dairy Sci., **9** (3), 105.

32 Venkayya, D. and Anantakrishnan, C. P. (1956), *Ibid.*, **9** (4), 164.

33 Venkayya, D. and Anantakrishnan, C. P. (1957), *Ibid.*, **10** (1), 20,

34 Sampath, S. R., Ananthakrishnan, C. P. and Sen, K. C. (1956), *Ibid.*, **9** (4), 177.

35 Narayanan, K. M., Anantakrishnan, C. P. and Sen, K. C. (1956), *Ibid.*, **9** (2), 87

36 Rao, V. N. (1957), Indian Farming, **7** (5), 32.

37 Mannar, M. C., Venkayya, D., Narayan, D. and Rangaswami, M. C. (1956), Indian J. Dairy Sci., **9** (4), 186.

38 Dastur, N. N. and Rao, M. B. (1956), Int. Dairy Congr., **3** (2), 69.

39 Rao, M. B. and Dastur, N. N. (1956), Indian J. Dairy Sci., **9** (3), 114.

40 Limdi, B. C. and Bhatt, S. S. (1957), Curr. Sci., **26** (4), 113.

41 Ahiya, L. D. and Gautam, A. N. (1956), Indian J. Dairy Sci., **9** (3), 109.

42 Kulkarni, P. S. and Dole, K. K. (1956), *Ibid.*, **9** (2), 68.

43 Khurody, D. N. (1957), Indian Dairyman, **9** (4), 136.

44 Paul, T. M. (1957), *Ibid.*, **9** (2), 71.

45 Dastur, N. N. (1956), Int. Dairy Congr., **3** (1), 203.

46 Kehar, N. D,, Ray, S. N. Joshi, B. C. and Raisarkar, B. C. (1956), Studies in Fats, Oils and Vanaspatis. Manager of Publications, Delhi, p. 5.

47 Sampath, S. R. and Anantakrishnan, C. P. (1956), Indian J. Dairy Sci., **9** (3), 135.

48 Seth, S. C. and Aggarwal, J. S. (1956), J. Sci. and Industr. Res., **15B** (1), 34.

49 Sampath, S. R., Anantakrishnan, C. P. and Sen, K. C. (1957), Indian J. Dairy Sci , **10** (1), 34.

50 Sampath, S. R. and Anantakrishnan, C. P. (1957), *Ibid.*, **10** (3), 147.

51 Hattiangadi, G. S. and Kanga, K. F. (1956), J. Sci. and Industr. Res., **15C**, (2), 49.

52 Kehar, N. D., Krishnan, T. S., Ray, S. N., Joshi, B. C. and Raisarkar, B. C. (1956), Studies in Fats, Oils and Vanaspatis, Manager of Publications, Delhi, p. 23.

53 Baliga, B. S. and Basu, K. P. (1956), Indian J. Dairy Sci., **9** (2), 95.

54 Apte, U. and Sohonie, K, (1957), J. Sci. and Industr. Res., **16C**, (12), 225.

55 Puri, B. R., Sharma, L. R. and Chandra, R. (1957), Indian J. Dairy Sci., **10** (2), 79.

56 Boman, T. J. and Dalal, U. C. (1956), *Ibid.*, **9** (3), 131.

57 Vachha, S. L., Leley, V. K., Narayana, N. and Daji, J. A. (1957), *Ibid.*, **10** (1), 6.

58 Tawde, S. and Magar, N. G. (1957), *Ibid.*, **10** (3), 137.

59 Subbaram, M. R. and Mahadevan, A, P. (1957), J. Sci. and Industr, Res., **16C** (6), 130,

60 Dave, B. S. and Om Prakash (1956), J, and Proc. Oil Technol. Ass. India, **12** (1), 29.

61 Narayana, R. and Kartha, A. R. S. (1956), J. Sci. and Industr. Res., **15B** (7), 368,

62 Kehar, N. D., Ray, S. N., Krishnan, T. S., Joshi, B. C. and Raisarkar, B. C. (1956), Studies in Fats, Oils and Vanaspatis. Manager of Publications, Delhi, p. 13.

63 Tawde, S. and Magar, N. G. (1957), Indian J. Dairy Sci.. **10** (1), 43.

64 Desikachar, H. S, R., Patwardhan, M. V., Sastry, L. V. L., Srinivasan, M. and Subrahmanyan, V. (1957), J. Sci. and Industr. Res., **16B** (5), 216.

65 Venkatachalam, V. and Sundaram, S. (1957), Curr. Sci., **26** (5), 157.

66 Mitra, S. N. and Roy, S. C. (1955), J, Ind. Chem. Soc,, Industr. Edn. **18** (3), 168.

67 Indian Food Packer (1957), **11** (7), 17.

68 Tawde, S. and Magar, N. G, (1957), Indian J. Dairy Sci., **10** (2), 73.

69 Kehar, N. D,, Krishnan, T. S., Ray, S. N., Kumar, J. and Pal, 1, A. K. (1956), Studies in Fats, Oils and Vanaspatis. Manager of Publications, Delhi, p. 31.

70 *Ibid.*, p, 57.

71 Kehar, N. D., Krishnan, T. S,, Ray, S. N., Kumar, I., Joshi, B. C., Pal, A. K., Sahai, K. and Chanda, R. (1956), *Ibid.*, p. 37.

72 Kehar, N. D., Ray, S. N., Krishnan, T. S., Joshi, B. C. and Pal, A. K. (1956), *Ibid.*, p. 91,

73 Kehar, N. D,. Krishnan, T. S. and Chanda, R. (1956), *Ibid.*, p. 79.

74 Kehar, N. D., Krishnan, T. S, and Joshi, B. C. (1956). *Ibid.*, p. 101.

75 Kehar, N. D., Krishnan, T. S. and Chanda, R. (1956), *Ibid.*, p. 85.

76 Dalal, S. H. (1957), Indian Dairyman **9** (9), 326,

77 Colbourne, M. J. and Sowah, E. M. A. (1956), Trans. Roy. Soc, Trop. Med., Hyg. **50** (1), 82.

78 Pathak, J. D. and Pai, M. L, (1956), J. Indian Med. Ass., **27** (3), 96,

79 Lal, S. B. and Bose, A. (1956), *Ibid.*, **27** (4), 136,

80 Baliga, B. R., Balakrishnan, S., Bhagavan, H. N. and Rajagopalan, R. (1957), J. Sci. and Industr. Res., **16C** (7), 152.

81 Srinivasan, R. A., Varma, K., Laxminarayana, H. and Iya, K. K. (1956), Int. Dairy Congr., **2** (1), 427.

82 Subrahmanyan, V., Sreenivasamurthy, V., Krishnamurthy, K., and Swaminathan, M. (1957), J. Sci. and Industr. Res., **16C** (12), 240.

83 Nambudripad, V. K. N., Laxminarayana, H. and Iya, K. K. (1956), Int. Dairy Congr., **1** (2), 388.

84 Gonsalves, A., Nambudripad, V. K. N., Laxminarayana, H. and Iya, K. K. (1957), Indian J. Dairy Sci., **10** (1), 25.

85 Nambudripad, V. K. N., Gonsalves, A., Laxminarayana, H., and Iya, K. K. (1957), *Ibid.*, **10** (3), 157,

86 Iyengar, M. K. K., Laxminarayana, H. and Iya, K. K. (1957), *Ibid.*, **10** (2), 90.

87 Laxminarayana, H., Sreenivasamurthy, V. and Iya, K. K. (1957), *Ibid.*, **10** (2), 49.

88 Sampath, S. R., Anantakrishnan, C. P. and Sen, K. C. (1957), **10** (1), 34.

89 Ray, S. C. (1957), Indian Dairyman, **9** (6), 221.

90 Sriraman, K. (1957), *Ibid.*, **9** (11), 413.

91 Govil, K. K., Bhatnagar, D. P. and Pant, K. C. (1956), J. Indian Med. Ass., **27** (7), 245.

92 Rawat, R. S. (1957), Indian Dairyman, **9** (4), 146.

93 Sundararajan, T.A. and Sarma, D.S. (1957), Biochem. J., **65** (2), 261.

94 Khurody, D. N. (1956), Int. Dairy Congr., **1** (2), 814.

95 Ray, S. C. (1957), Indian Dairyman, **9** (10), 359 ; and **9** (11), 403.

96 Indian Dairyman (1957), **9** (3), 107,

97 Falkenhahn, W. V. (1957), *Ibid.*, **9** (11), 400.

98 Chandrasekhara, M. R., Swaminathan, M. and Subrahmanyan, V. (1957), *Ibid.*, **9** (1), 38.

99 Galsman, I. and Hansan, J. P. (1957), *Ibid* , **9** (10), 362,

100 Chakravarti, D. (1956), Diss. Abs., **16** (3), 412.

101 Indian Dairyman (1957), **9** (1), 2.

102 Subrahmanyan, V., Chandrasekhara, M. R., Swaminathan, M. and Bhatia, D. S. (1957), Indian Dairyman **9** (7), 276,

103 Subrahmanyan, V., Chandrasekhara, M. R., Swaminathan, M. and Bhatia, D. S. (1957), Food Sci., **6** (10), 238.

104 Chandrasekhara, M. R., Swaminathan, M., Bhatia, D. S. and Subrahmanyan, V. (1957), *Ibid.*, **6** (10), 226.

105 Chandrasekhara, M. R., Sreenivasamurthy, V., Swaminathan, M., Bhatia, D. S. and Subrahmanyan, V. (1957), *Ibid.*, **6** (10), 228.

106 Chandrasekhara, M. R., Swaminathan, M., Bhatia, D. S. and Subramanyan, V. (1957), *Ibid*,, **6** (10), 232.

107 Chandrasekhara, M. R., Doraiswamy, T. R., Swaminathan, M., Bhatia, D. S., Sankaran, A. N. and Subrahmanyan, V. (1957), *Ibid.*, **6** (10), 241.

108 Khurody, D. N. (1956), Int. Dairy Congr., **1** (2), 610.

109 Indian Dairyman (1957), **9** (6), 233.

110 Salpekar, Y. V. (1956), Int. Dairy Congr., **1** (2), 704.

111 Panse, V. G. (1956), *Ibid.*, **1** (2), 653.

112 Leader (1956), Aug. 12th. Leader Press, Allahabad.

113 Indian Food Packer (1956), **10** (12), 15.

114 Jensen, H. (1957), Indian Dairyman, **9** (1), 35,

115 Medora, P. and Variava, R. (1956), Int. Dairy Congr., **2** (1), 262.

AUTHOR INDEX

PAGE

Abrol, B. K. 79
Achaya, K. T. 118, 119
Achinstein, B. 63, 69
Agarwal, K. L. 158, 159
Agarwala, O. P. 171
Agarwal, R. P. 119
Agarwala, S C. 9, 4, 3
Agarwal, S. L. 64, 67, 68
Aggarwal, J. S. 117, 122, 172
Aggarwal, O. P. 100
Agnihothrudu, V. 52
Agrawal, J. S. 116
Agrawal, S. L. 67
Ahalya Rao 34
Ahiya, L. D. 172
Ahluwalia, V. K. 110
Ahmad, A. 61
Ahmed, A. 64, 162
Aiyar, S. N. 111
Ajmani, V. 118
Alfonso, A. 78
Alimchandani, H. R. 23, 24, 25, 38, 39
Altekar, W. W. 21, 73
Ambegaokar, S. D. 145
Anand, J. C. 42
Anand, N. 78
Anand, V. D. 54
Anandswami, B. 109, 122
Anantakrishnan, C.P. 171, 172, 173, 178
Andleigh, H. S. 47
Antia, F. P. 66
Appaji Rao, N. 6
Apte, U. 7, 114, 133, 173
Aravindakshan, I. 5
Arora, K. K. 51
Arora, M. M. 47, 162
Arora, R. B. 61, 62, 63, 65, 67, 68, 123
Arsiwala, S. M. 73
Atanackovic, D. 63
Ayer, W. A. 91

Babbar, O. P. 48
Bagchi, R. 118
Bahadur, K. 4
Bains, G. S. 109
Bajaji, V. 41
Bakshi, B. K. 52
Bakshi, R. K. 51
Bakshi, V. N. 71
Bal, A. K. 122
Balakrishnan, S. 15, 16, 39, 177

PAGE

Balasubrahmanyan, G. 115
Balasubramanian, S. C. 135
Balasundaram, S. 12
Baldridge (Jr.), H. D. 98
Baliga, B. R. 15, 16, 39, 177
Baliga, B. S. 173
Balwani, J. H. 65
Bami, H. L. 77, 78
Banerjea, A. 47, 48
Banerjee, A. K. 34
Banerjee, B 123, 143
Banerjee, B. N. 41
Banerjee, D. K. 156
Banerjee, G. 38, 47, 48
Banerjee, R. M. 123, 133
Banerjee, R. P. 103
Banerjee, S. 2, 17, 47, 48, 51, 134, 143, 144, 153, 159, 160, 163, 164, 165
Banerjee, S. C. 74, 119
Banerjee, S. N. 123, 134
Banick, U. K. 124
Banker, D. D. 49
Bannerjee, B. 79
Bannerji, D. 75, 78
Bannerjee, G. 75
Bannerjee, J. N. 66
Barton, D. H. R. 91
Barua, A. K. 92, 93, 95, 106
Barua, G. C. S. 52
Baruah, H. K. 107
Barucha, F. R. 114
Basak, R. 17
Basu, A. K. 156
Basu, B. 155
Basu, K. P. 173
Basu, N. K. 95, 100. 101, 102, 121
Basu, P. C. 78
Basu, P. K. 49
Basu, R. K. 66
Basu, S. P. 44, 104, 148
Basu, S. N. 53, 76, 121, 122
Basu, V. P 78
Basu Roy, B. 44
Batra, L. R. 52
Bawa, Y. S. 161
Baxi, A. J. 146, 147
Behki, R. M. 27
Bedi, K. S. 49
Bhaduri, J. N. 47, 160
Bhaduri, N. V. 78
Bhagavan, H. N. 16, 39, 122, 177

PAGE

Bhagavan, N. V. 37
Bhagavan, R. K. 138
Bhagwat, R. R, 46
Bhandari, P. R. 101
Bhanumathi, M. 76
Bharadwaj, T. P. 8
Bhargava, K. P. 62, 64
Bhargava, K. S. 53
Bhargava, P. P. 117
Bhargava, R. K. 163
Bharucha, E. P, 61
Bharucha, F. R. 14, 106, 113
Bhaskaran, K. 37
Bhat, J. V. 36, 170
Bhat, S. G. 108
Bhatia, A. L. 155
Bhatia, B. S. 137
Bhatia, D. S. 109, 121, 137, 169, 179
Bhatnagar, D. P. 178
Bhatnagar, J. N. 67, 102, 121
Bhatnagar, S. S. 45, 75, 76
Bhatt, P. N. 48
Bhatt, R. H, 68
Bhatt, R, P. 121
Bhatt, S. S. 172
Bhattacharjee, B. 76
Bhattacharjee, K. L. 155
Bhattacharji, S. 102
Bhattacharya, A. 44
Bhattacharyya, A. 104, 105
Bhattacharya, B. K. 63, 66, 71, 80, 116
Bhattacharya, H. 21
Bhattacharya, K. R. 29, 40, 120
Bhattacharya, S. 118
Bhide, N. K. 79, 121
Bhide, V. P. 41, 52
Biswas, A. K. 118, 119
Biswas, D. K. 134, 143, 153
Biswas, N. R. D. 120
Boman, T. J 174
Borison, H. L. 64, 71
Bose, A. 155
Bose, A. N. 145
Bose, A. K. 38
Bose, B. (Mrs.) 102
Bose, B. C. 64, 66, 67, 102, 121, 163
Bose, B. G. 67
Bose, J. L. 75
Bose, P. G. 76
Bose, P. K. 45, 91, 124
Bose, S. 100
Bose, S. N. 72, 120
Bose, S. K. 34, 75
Bose, S. R. 35
Boyce, S. F. 91
Braganca, B. M. 5
Bromwich, D. W. 48

PAGE

Cama, H. R. 12, 14
Chandra, R. 175, 176
Chander, K. 110
Chandra, K. 75
Chandra, R. 173
Chandra, V. 50
Chandrasekhar, M. R. 3, 137, 169, 178, 179
Chandra Sinha, R. 4
Chakraborty, A. N. 34
Chakraborty, B. M. 34
Chakraborty, C. H. 74
Chakraborty, D. P. 45, 104
Chakraborty, M. M. 117, 118
Chakraborty, N. K. 118
Chakraborty, S. R. 117, 118
Chakravarti, D. 93, 95, 178
Chakravarti, D. P. 124
Chakravarti, H C. 104
Chakravarti, H. S. 124
Chakravarti, I. B. 107
Chakravarti, M. M. 115
Chakravarthy, N. K. 61, 71,
Chakravarti, R. N. 30, 72, 77, 78, 79, 93, 95, 96, 101, 104, 123, 164, 165
Chakravarti, T. 121
Chari, S. T. 136
Chatterjee, A. 61, 65, 93, 99, 100, 101, 121
Chatterjee, A. N. 49
Chatterjee, A. N. 49
Chatterjee, B. R. 48
Chatterji, D. N. 47
Chatterjee, I. B. 7, 26, 166
Chatterjee, J. 2
Chatterjee, J. B. 148, 156
Chatterjee, K. 159
Chatterjee, K. R. 48
Chatterjee, M. L. 65, 66, 102, 103
Chatterjee, R. 119
Chatterjee, R. K. 121
Chatterjee, R. R. 77
Chatterjee, S, P. 48
Chattopadhyay, S. B. 49, 51, 164
Chaudhury, A. 79
Chaudhury, D. K. 134
Chaudhury, G. R. 122
Chaudhury, N, A. 101
Chaudhury, R. N. 73, 77, 79, 104, 123, 148
Chaudhury, S, N. 48
Chaudhury, S, S. 99, 106, 115, 116
Chavan, M. H. 68
Chibber. S. S. 111
Chiddarwar, P. P. 34
Chiniwala, E. H. 117
Chitre, R. G 17, 18, 21, 73, 146

PAGE
Chona, B. L. 52
Chopra, C. L. 44, 77
Chopra, I. C. 44, 67, 75, 79
Chopra, I. I. 77
Choudhury, S. 50
Chowdhury, A. N. 73
Chowdhury, D. K. 117, 118
Chowdhan, J. S. 66
Colbourne, M. J. 176
Crookes, H. M. 95

Daji, J. A. 174
Dakshinamurthy, C. 120
Dalal, S. H. 176
Dalal, U. C. 174
Damle, S. P. 41
Damodaran, A. P. S. 53
Dandiya, P. C. 63, 67, 68, 123
Darekar, M. R. 49
Daruvala, E. D. 122
Das, B. R. 45, 75, 120
Das, D. B. 108
Das, M. L. 18, 104
Das, M. S. 76
Das, N. B. 123, 133
Das, N. N. 65
Das, P. 79
Das, P. K. 63, 68
Das Gupta, A. 35, 44, 45, 124
Das Gupta, B. 101
Das Gupta, S. 100, 122
Das Gupta, S. K. 161
Das Gupta, S. R. 61, 62, 65
Dash, S. 96
Dass, I. 101
Dastur, N. N. 170, 172
Datar, D. S. 123
Datey, K. K. 157
Datta, J. 40, 120
Datta, S. K. 20
Dave, B. S. 174
De, H. N. 73
De, M. S. 65, 66, 102, 103
De, N. K. 14, 73, 165
De, N. N. 63, 65, 71, 72
De, U. N. 30, 72, 163, 164
Deb, C. 2
Deb, S. 92
Delima, T. 71
Deolalkar, S. T. 6, 8, 16
De Sa, J. 76
Desai, C. M. 117
Desai, D. B. 17
Desai, M. K. 52
Deshpande, S. S. 117
Deshpande, V. N. 45
Desikachar, H. S. R. 174
De Souza, E. J. 1

PAGE
Dev, S. S. 75
Dey, L. M. 118
Dey, P. K. 105
Dhala, S. A. 45
Dhar, M. L. 43, 63, 78, 91, 102
Dhar, M. M. 46, 48, 66, 75, 102, 120
Dhawan, B. N. 61, 70 71, 80
Dhinagra, D. R. 119
Dhopeshwarkar, G. A. 80
Dikshit, P. K. 14, 165, 166
Dikshit, P. R. 28
Divekar, P. V. 76
Dixit, C. H. 72, 144, 156
Dixit, R. S. 79
Dixit, Y. H. 162
Doctor, R. B. 71
Dole, K. K. 116, 172
Doraiswamy, T. R. 137, 148, 179
Dudani, A. T. 155
Dumbrey, D. G. 49
Dutt, A. S. 107
Dutt, I. 41
Dutt, S. 94
Dutta, A. B. 123
Dutta, A. G. 78
Dutta, B. N. 77
Dutta, N. K. 121
Dutta, S. K. 38

Esh, G. C. 1, 114, 146

Falkenhahn, W. V. 178
Fatterpaker, P. 73
Fernander, F. 75, 76
Frantz, J. 66

Gaitonde, B. B. 67, 68, 147, 158
Galsman, I. 178
Ganapathi, K. 45
Ganapathy, N. S. 146
Ganatra, R. D 80
Ganguli, A. K. 111
Ganguli, D. 118
Ganguli, J. 4, 13
Ganguli, N. C. 76, 116
Ganguli, S. 36
Ganguli, S. K. 21
Ganju, P. L. 37
Gautam, S. K. 115
Gautam, A. N. 162
Gersdorff, C. E. F. 133
Ghai, S. N. 115
Ghanekar, D. S. 5
Ghatak, S. 78
Ghosh, A. K. 2
Ghosh, B. P. 66
Ghosh, H. 45, 47, 120, 163
Ghosh, J. J. 7, 26, 49, 160

PAGE

Ghosh, N. C, 7, 18, 26, 104, 166
Ghosh, P. K. 156
Ghosh, R. 93
Ghosh, S. 74
Ghosh, S. K. 156
Ghosh, S. N. 2, 75
Ghosh, S, R. 20, 38
Ghosh, T. 52
Giri, K. V. 6, 79, 113, 123, 135, 159, 160
Gode, K. D. 101, 102
Godbole, S. H, 5, 157
Godbole, G, S. 169
Gokhale, S. K, 21, 73, 146, 157
Gokhale, S. V, 5
Gondhalekar, R. S. 35
Gonsalves, A. 42, 177
Goodman, S. L. 61
Gopalan, C, 143, 144, 148, 149, 154, 155, 163, 165
Gopalachari, R. 43
Gopinath, K, W. 99
Goswami, M. N. 118
Goswami, R, 61
Govil, K. K, 178
Govindachari, T, R. 93, 96, 97, 98, 99, 112
Grewal, J. S. 41, 52
Grover, R . D, 77
Guha, A. 37
Guha, B.C. 7, 18, 26, 41, 79, 104, 117, 166
Guhu, D K. 47
Guha Roy, U. K. 47
Guha Sarkar, S, S. 74
Guha Thakurte, A. K. 45, 123
Gujral, M. L. 60, 61, 62, 57 70, 71, 73, 74, 79, 80
Gupta, D. K 117
Gupta, G. N. 119
Gupta, G. S. 64
Gupta, J. P. 169
Gupta, R, C. 76, 77
Gupta. K. K. 144, 155
Gupta, P, S. 2
Gupta, R R, 77
Gupta, S. C. 53
Gupta, S. K. 46, 75, 77
Gupta. S. R. 106
Gupta. S. S. 67, 102, 163
Gupta, V. N. 110
Gupta, T. R. 44, 76
Gurnani, S. D. 146, 147

Haksar. C. N, 117
Hameed, K. A. 71
Handa, K. L. 93, 104, 106, 115, 116
Hansen, J. P. 178

PAGE

Harvey, S, C. 64
Hattiangadi. G. S. 173
Hatwalne. B. V. 6, 26, 123
Hausler, H. F. 61, 62, 65
Hussain, S. M. 116

Indira, M. 36, 66, 75, 108
Indrawat, D. 14, 153
Iya, K. K. 42, 170, 177
Iyengar, B. T. R. 117
Iyengar, J. R. 121
Iyengar, M, R. K, 177
Iyengar, M. R. S. 37
Iyengar, M. V. R. 122
Iyer, G. Y. N. 157
Iyer, P. V. K, 144, 155
Iyer, R. N. 43, 78

Jain, N. L. 109
Jadhav, M. A. 147, 158
Jamwal, K, S. 67
Jayalakshmi, V. T. 148, 154, 155
Jensen, H. 179
Jensen, R. 71
Jhala, H. I. 49, 72, 144, 156
Jindal, M. L. 69, 71, 77
Johar, D. S. 17, 39, 42, 45, 121, 124, 133
Jones, D. B. 113
Joseph, A. D. 71
Joseph, K. 136, 137, 148
Joshi, B C. 172, 173, 174, 175, 176
Joshi, B. N. 92
Joshi, D. V. 91, 121
Joshi, G. V. 144
Joshi, J. G. 28, 166
Joshi, M. R. 20, 114, 122

Kale, G. V. 50
Kalra, L. 49
Kalyanasundaram, R. 20
Kamat, S. R. 46
Kamat, V. N. 76
Kannan, A 169
Kanga, K. F. 173
Kapoor, J. N. 52
Kar, P. K. 80
Kartha, A. R. S. 174
Kasbekar, D. K. 25
Kaul, K. N. 95
Kaul, P. N. 104
Kaushiva, B. S. 43, 44, 78
Kavan, S. 159
Kekre, M. S. 67, 68
Kehar, N. D. 54, 172, 173, 164, 175, 176
Khambata, S. R. 36
Khanna, D. K. 61, 62

PAGE

Khanna, M. L. 52
Khanna, N. M, 63
Khanolkar, V. R. 29, 154
Khajaria, B. N. 44, 75
Khorana, M. I. 68
Khorana, M. L. 78, 121
Khurody, D. N. 169, 170, 172, 178, 179
Khirwadkar, M. G. 66
Kishor, K. 71
Kohli, J D. 63, 65, 66, 102
Kohli, M. L, 170
Kohli, R. P. 60, 62, 66
Konar, N. R. 154
Konovalova, R, A. 97
Koteswara, D, K, 51
Kothari, G. 144
Kothari, N. J. 65, 123
Kothare, S. N. 1
Krishna, B. 72, 164, 165
Krishna, B. H. 109
Krishna, H. J. V, 92
Krishna, P. S. 41
Krishnan, T. S. 173, 174, 175, 176
Krishnan, T. S. S. 92
Krishnaswamy, K. V. 44
Krishnaswamy, N. 117
Krishnaswamy, P. R. 6, 123
Krishnamurthy, C. R. 3, 53
Krishnamurthy, K, 39, 44, 122, 177
Krishnamurthy, S. 4, 13
Kulkarni, B. S. 5
Kulkarni, P, S. 172
Kulsreshtha, J. K. 61, 62, 69
Kumar, A. 158, 159
Kumar, I, 175
Kumar, S. 158, 159
Kumaran, J. D. S. 170, 171
Kumta, U. S. 146, 147
Kumta, V. S. 1
Kumperman, A. S. 64
Kuppuswami, S. 136
Kurup, P. A. 45, 75, 76, 120
Kuschke, H. J. 66

Lahiri, S. C. 61, 63, 70, 79
Lakshikanthan (Miss), M. V, 97
Lakshmanan, M. 35
Lakshminarayan, K, 35
Lakshminarayana, S. K. 109
Lal, A, 67
Lal, G. 109
Laskar, G, K. 143
Laskar, S, L, 77
Laxminarayana, H, 42, 177
Laumas, K. R. 112
Lele, V. C. 50
Leley, V, K. 174
Lewis, J. J. 66

PAGE

Lewis, G. P. 66, 80
Lewis, R. A. 75, 80
Limdi, B. C. 172
Lokre, R. J. 46
Lulla, B. S. 17, 39, 45, 121, 124, 133

Macmillan, W. G. 53, 107, 121, 122
Madan, B. R. 61, 65, 67
Magar, N. G. 28, 174, 175
Mahadevan, A. P. 174
Maiti, A. 69, 105
Maiti, P. C. 92, 119
Majumdar, S. K 37, 75
Makhija, J. R. 162
Malakar, M. C. 123, 134
Malati, A. 158
Malhotra, C. L. 61, 66
Malhotra, M. K. 104
Mangalik, V. S. 158, 159, 165
Mangar, N. G, 116
Manjrekar, P. S. 8, 46
Mannar, M, C. 171
Manske, R. H. F. 98
Marathe, K. G. 110
Marathe, V. G, 73
Maratia, W. 73
Marker, R, E. 95
Matallane, A. M. 71
Mathur, I. S. 46
Medora, P. 179
Mehrotra, R. M. L. 165
Mehta, S. 61
Menon, T. C. K 93
Menon, T. M. 93
Merchant, R. C. 68
Metha, J. V. 47
Misra, B. G. 77
Misra, D. P. 50
Mishra, S. S. 69, 79
Mitra, B. R. 134
Mitra, C. 95, 117, 122
Mitra, C. R. 118
Mitra, K. K. 36
Mitra, M. N. 95
Mitra, N. K. 108
Mitra, S. N. 113, 121, 175
Mittal, O. P. 119
Modawal, C. N. 117
Mody, B. M. 72
Mody, B. N. 144, 156
Mohan Rangam, C, 8
Momen, S. A. 93
Mondkar, U. P. 61
Moudgal, N. R. 105, 137
Mukerjea, T. D. 79
Mukerjee, N. 48
Mukerjee, S. 47, 107
Mukerjee, S. K, 111

PAGE

Mukerjee, S. R. 105
Mukherji, A. 49, 76
Mukherjea, A. K. 34, 43
Mukherjee, A, M, 148
Mukherji, B. 30, 43, 72, 77, 163, 164, 165
Mukherji, B. K. 117
Mukherjee, D. K. 118
Mukherjee, D. P. 162
Mukherjee, K. C. 148
Mukherjee, K. L, 61, 65, 70, 149
Mukherjee, M, K. 54
Mukherjee, K. N. 61
Mukherjee, S, K, 30, 72, 163
Mukherjee, S, L. 77
Mudaliar, V. T. S, 170
Mulgaonkar, A. G. 22
Munjal, R. L. 52
Murthy, B. R. 38, 105
Murthy, H. B. N. 3, 122
Murthy, K. N. 107
Murthy, P. S. 76
Murthy, V. N. 54
Murthi, V. V. S. 111
Muthu, M. 122

Nadkarni, G. B. 19, 21, 22, 25
Nag, S. 107
Nagabhushanam, A, 8
Nagarajan, K. K. 93, 97, 99, 112
Naha, J. 77
Naidu, M. B. 115
Naik, M. G. 65, 123
Nambudripad, V. K. N. 42, 177
Nand, N. 71
Nanda, K. L. 79
Nandi, P. N. 35
Nandy, K. 44
Narang, S. A. 116, 119
Narasimhan, N. S. 98, 99, 123
Narayan, D. 171
Narayana, C. S. 121
Narayana, N. 174
Narayanamurthi, D. 122
Narayanan, K. M. 171
Narayanan, M. S. 20, 22, 156
Narayana Rao, D. 27, 166
Narayana Rao, M. 148
Narayana Rao, M. N. 73
Narayanaswami, S. 51
Narurkar, M. V. 1
Natarajan, C. P. 121
Natarajan, S. 76
Nath, B. 99, 100, 122
Nath, A. K. 157
Nath, H. P. 144, 155
Nath, M. C. 27, 74
Natb, M, G. 27

PAGE

Nath, R. 113, 135, 159
Nath, R. L. 5, 149
Navani, H. 162
Nayak, N. C. 165
Nayudu, S. C. 74
Neelakantan, S. 112
Nerurkar, M. K. 146
Nigam, S. K. 95
Nimbkar, Y. S. 37, 48
Nityanand 43
Nizamuddin, H. 5

Ojha, K. N. 80
Ojha, V. N. 117
Om Prakash 174
Osmani, Z. H. 115

Padma, M. C. 37
Padmanathan, S. Y. 52
Pai, A. K. 175, 176
Pai, B. R. 93, 97, 112
Pai, M. L. 28, 29, 134, 162, 176
Pain, S. K, 144, 163
Pal, P. N. 53, 121, 122
Pal, P. R. 41
Palit, D. 115
Palit, S. R. 121
Pandya, R. N. 117
Pankajamani (Miss), K. S. 106
Panse, T. B. 29, 154
Panse, V. G. 179
Pant, K, C. 178
Pant, K. D. 3, 53
Parekh, J. G. 72, 144, 156
Parthasarathy, P. C. 112
Patel, B. D. 147, 158
Patel, R. J. 67, 68
Patel, K. C. 44, 76 121
Patel, M. K. 49, 50, 51
Patel, R. P. 44
Patel, T. V. 28, 29
Pathak, J. D. 176
Pathak, M. A. 9, 161
Pathak, R. K. 67
Pathak, S. P. 118
Pathak, T. C. 163
Pathak, V. S. 116
Patwardhan, M. V. 9, 174
Patwardhan, V. N. 28, 133, 166
Paul, T. M. 172
Paul, V. 104, 116
Pavanaram, S. K. 110
Pawar, V. H. 50, 51
Perti, S. L. 79
Phadke, R. S. 35
Phansalkar, S. V. 72, 133
Patak, K. D. 116
Pillai, N. C, 14, 79, 122, 160

	PAGE
Pillai, P. P.	67
Pingale, S. V.	122
Poddar, R. K.	77
Pohowalla, S. N.	47
Poonawalla, F. M.	45, 75
Popli, S. P.	43, 77
Prabhu, K. A.	37
Pradhan, S. K.	28, 73
Pradhan, S. N.	63, 69
Pramanic, K.	47
Prasad, N.	50
Prasad, R. B.	52
Prasad, S.	104
Proskurnina, N. F.	97
Pujari, H. K.	78
Puntambekar, S. V.	116
Purandare, B. N.	159
Puri, B. R.	54, 173
Radhakrishnamoorthy, R.	29, 73
Radomin, S.	75
Raghavan, V.	107
Raha, C. R.	106
Raisarkar, B. C.	172, 173, 174
Raiver, K. P.	67
Rajadurai, S.	96, 98, 99
Rajagopalan, R.	15, 16, 39, 122, 177
Rajagopalan, V.	61
Rajappa, S.	97, 99
Rajapurkar, M. V.	63
Rakhit, S.	95, 102, 121
Ram, C. S. V.	35
Ram, R.	122
Ramachandran	162
Ramachandran, B. V.	114, 135
Ramachandran, M.	133, 135
Ramakrishnan, C. V.	41
Ramakrishnan, K.	50, 52
Ramakrishnan, T.	36, 108
Ramakrishna, T. S.	52
Ramamoorthy	157
Raman, S. P.	93
Ramanathan, M. K.	72, 143, 148, 154, 155, 160
Ramanathan, K. S.	144, 149, 155, 165
Rama Rao, G.	3
Ramasarma	72
Ramasarma, G.B.	20, 22, 135,144, 156
Ramaswami, A. S.	75, 123
Ram Prasad, C.	66, 70
Rene, M. S.	52
Rangam, M. C.	46
Rangan, M. C.	46
Ranganathan, B.	39
Ranganathan, S. K.	79
Rangaswami, C.	75
Rangaswami, G.	50, 51, 53

	PAGE
Rangaswami, M. C.	171
Rangaswami, N. S.	51
Rangaswami, S.	69, 92, 107, 121
Rao, A. V.	50
Rao, B. S. N.	148, 154
Rao, E. V.	69, 107
Rao, G. J. S.	79, 122
Rao, G. R.	136
Rao, G. S.	147, 158
Rao, G. S. K.	92
Rao, K. H.	113, 135
Rao, K. R.	77
Rao, K. S.	72
Rao, K. V.	91
Rao, K. V. J.	101
Rao, M. B.	172
Rao, M. H.	50
Rao, M. N.	45, 124, 133, 136, 137
Rao, M. S. S.	52
Rao, M. V. L.	114, 135
Rao, M. V. R.	138, 139, 141, 142
Rao, N. A.	123
Rao, N. S. S.	52
Rao, P. G.	53
Rao, P. L. N.	44, 45, 75, 76, 120
Rao, P. N.	52
Rao, P. R.	122
Rao, P. S.	106
Rao, R. R.	66, 76, 80
Rao, S. R.	116
Rao, S. S.	37
Rao, T. L. N.	123
Rao, V. N.	171
Rapoport, H.	98
Rastogi, R. P.	63, 94
Rant, V. S.	18
Rawat, R. S.	169, 178
Ray, A. P.	77, 78
Ray, C.	63, 65
Ray, H. N.	34, 43, 48, 61
Ray, S.	43
Ray, S. C.	178
Ray, S. N.	172, 173, 174, 175, 176
Ray Chaudhuri, B.	145
Raymabargi, S.	77
Razdan, M.	27
Razdun, M.	65
Rehille, P. S.	52
Rehsi, S. S.	122
Reichstein, T.	91
Rindani, T. H.	8, 65, 66, 68, 123
Row, L. R.	110
Row, R.	101
Roy, A. B.	54
Roy, A. N.	48, 75
Roy, B. B.	64
Roy, B. R.	12, 117
Roy, D. K.	3, 38, 40, 41, 47, 120

PAGE
Roy, J. 78
Roy, P. 118
Roy, R. N. 7, 26, 156, 166
Roy, S. 93
Roy, S. C. 175
Roy, S. K. 101
Royalo, E. E. 92
Rudra, B. C. 47
Rudra, B. K. 75

Sachdev, J. C. 161, 165
Sachdev. S. 161
Sadagopal 94, 119
Sagar, P, 9, 43
Saha, A, N. 118
Saha, J. G. 118
Saha, K. 48
Saha, S, K. 121
Saha, T. K, 73
Sahai, K, 175
Sahasrabudhe, M. B, 1, 146, 147
Saifi, A. Q. 67, 102
Salam, M, A. 52
Saletore, S. A. 116
Salpekar, Y. V, 179
Sambamurthy, K. 92
Sampath, S. R. 172, 173, 178
Sampathkumaran, K, S. V. 2
Sankaran, A. N. 136, 137, 179
Sankhala, R. H. 41
Santhakumari, T. N, 67
Sanyal, P. N. 69
Sanyal, S, N. 74
Saraf, V. A, 116
Sarcar, A. K. 160
Sarcar, S, 52
Sareen, K. N. 60
Sarin, J. C. 47
Sarin, L. R. 163
Sarkar, A. K. 47, 165
Sarkar, N. K. 75
Sarkar, S. 115
Sarkar, S, R. 28
Sarma, D. S. 178
Sarma, P. S. 2, 7, 19, 21, 29, 37, 39, 73, 105, 115, 120, 137, 166
Sastri B. V. R. 14
Sastri, R. 163
Sastry, C. A. 39
Sastry, K S. 39, 120
Sastry, L, V. L, 9, 122, 174
Sastry, P. S. 13
Sathe, V. R. 29, 154
Sataskar, R. S. 75
Satwalekar, S. S, 44, 76
Saunders, P, R. 69
Savrin, L. R. 44
Savur, G. R. 4, 109

PAGE
Saxena, G. M. 111
Saxena, K. C. 9, 43
Saxena, P. N. 60, 61, 62, 70, 71, 73, 79, 80
Schaffner, C. P. 75
Schuler, W. 66
Sen, G, P. 102, 103
Sen, J. 74
Sen, K. C, 171, 178
Sen, K. N. 63
Sen, P. B. 79
Sen, R. 153
Sen, S. 80
Sen, S. C. 80
Sen Gupta, A. 115, 118
Sen Gupta, A. B. 107
Sen Gupta, K. P. 76
Sen Gupta, P. C. 148
Sepaha, G. C. 72, 120
Seshadri, T. R. 77, 106, 110, 111, 112, 119
Seshadri Sastry, P. 4
Seth, D. 66, 103
Seth, S. C. 172
Sethe, K. 53
Sethi, M. S. 70
Sethi, S. C. 122
Sethi, T. S. 52
Shah, N. M. 46
Shah, V. R. 62
Shahani K. M. 169
Shankar, J. V. 106
Shankaranarayana, K. A. 14, 113
Shanta 159
Shantha Rao, S. 4
Sharma, A. K. 122
Sharma, L. R. 173
Sharma, P. G. 117
Sharma, R. S. 162
Sharma, S. L. 50
Sharma, T. R. 33
Sharma, V. N. 62, 67, 95, 101
Shear, M. J. 63, 69
Shenoy, K. G. 20, 22, 156
Sheth, K. 3, 46, 75, 120
Sheth, U. K. 121, 157
Sheth, V. K. 62, 67, 79, 80
Shpanov, V. N. 97
Shrikantan, T. N. 9, 43
Shrivastava, A. N. 107
Shrivastava, D. L. 9, 43
Shrivastava, J. B. 9, 38, 161
Shroff, F. N. 67
Shroff, L. T. 170
Shukla, J. P. 33, 37
Siddappa, G. 8
Siddappa, G. S. 122, 137
Sidhu, R. K. 66

PAGE

Singh, B. N. 47
Singh, G. 41, 162
Singh, H. 93, 104, 106, 116
Singh, H. K. 100
Singh, J. 41
Singh, K. P. 67, 69
Singh, M. 79
Singh, M. M. 162
Singh, R. C, 161
Singh, S. 51, 79
Singh, S. G. 169
Singh, T. 104
Sinha, K. N. 63
Sinha, R. L. 51
Sinha, S. 117
Sinha, Y. K. 62, 63, 68, 70
Sirsi, M. 36, 46, 66, 70, 75, 76, 79, 80, 108, 122, 123
Sivaramakrishnan, R. 21
Sivaramakrishnan, V. M. 7
Sivarama Sastry, K. 29
Sohonie, K. 6, 7, 8, 16, 20, 26, 114, 122, 123, 133, 135, 173
Som, J. M. 1, 114, 146
Soman, D. W. 48
Sowah, E. M. A. 176
Sreenivasan, A. 19, 21, 22, 23, 24, 25, 37, 38, 39, 73
Sreenivasan, K. S. 119, 122
Sreenivasan, V. R. 105
Sreenivasamurthy, V. 20, 39, 44, 122, 177, 179
Srikantia, H. 159
Srikantia, S. G. 149
Srimany, S, K. 93
Srinath, V. 109
Srinivasan, K. S. 8
Srinivasan, M. 8, 114, 160, 174
Srinivasan, R. A. 177
Srinivasan, V. 105, 137
Srinivasa Rao, S. 4
Sriraman, K, 178
Srivastava, S. K. 66, 102
Stenhauer, A. J. 101
Subbaram, M. R. 174
Subba Rao, N. S. 120, 123
Subbiah, J. 53
Subbu, V. 63
Subrahmanyam, S. 63
Subrahmanyam, V. V. R. 118, 119
Subrahmanyan, V. 20, 39, 44, 45, 109, 122, 124, 133, 136, 137, 138, 148, 169, 174, 177, 178, 179
Subramanian, M. K. 33
Subramanian, C. V. 52
Subramanian, D. 35
Subramanian, M. 99

PAGE

Subramanian, N. 114
Subramanian, P. 111
Subramanian, T. V. 51
Sukapure, R. S. 49
Sukhdev 52
Sundaram, N. V. 50
Sundaram, V. 175
Sundararajan, T. A. 2, 178
Sundaresan, P. R. 12, 14
Sundaresan, V. 111
Sur, A. N. 71
Suri, K. R. 170
Swaminathan, M. 3, 20, 39, 44, 45, 122, 124, 133, 136, 137, 138, 148, 169, 177, 178, 179

Talageri, V. R. 29, 154
Talapatra, S. K. 65, 99, 101
Tamhane, R. G. 121
Taskar, A. D. 72
Tata, J. R. 74
Tawde, S. 174, 175
Taylor, N. R. W. 64
Taylor, W. I. 91
Tangmani, A. 19, 166
Tapur, P. N. 169
Thind, K. S. 52
Thyagarajan, B. S. 99
Thyagarajan, T. R. 33
Thirunarayanan, M. O. 46, 66, 75, 76
Tiwari, R. S. 60, 74
Tripathi, R. L. 79
Trivedi, B. M. 44, 76, 121
Tsukamoto, T. 95
Turner, D. L. 95

Udani, P. M. 148
Udwadia, F. E. 157
Ullah, R. 5
Ulshafer, P. R. 95
Upadhyaya, M. M. 118

Vachha, S. L. 174
Vakil, R. J. 67
Valanjee, V. N. 8
Valanju, N. N. 135
Vahia, N. S. 61
Vaidya, M. D. 46
Vaidyanathan, C. S. 79
Vaidyanathan, N. 44
Van Italli, T. B. 101
Variava, R. 179
Varma, D. R. 74
Varma, J. P. 122
Varma, K. 177
Varma, K, R. 118
Varma, T. N, R. 12

PAGE

Vasavada, P. S. 162
Vasudeva, R. S. 50
Vaz, A. 76
Venkataraman, R. 36
Venkataramani, B. 111
Venkatachalam, G. 174
Venkateshan, C. 14
Venkateswarlu, P. 27, 166
Venkayya, D. 171
Verghese, J. 92
Vijayavargiya, R. 66, 67, 102, 121
Vishwa Karma P. 70
Visvanathan, L. 37
Viswanathan, N. 99
Viswanathan, R. 76, 77
Volcheck (Jr.), E. J. 98
Vora, V. C. 46, 75, 77, 120

Wagle, D. S. 21
Wagner, R. B. 95
Wahi, P. N. 162
Waksman, S. A. 75
Wareham, J. F. 108
Werner, G. 65, 70
Wettle, E. L. 95
Woodbury, D. M. 61
Work. T. H. 48

Yeddanapalli, L. M. 92

Zutshi, N. L. 94

SUBJECT INDEX

PAGE

Actinomycetes 45
Alcaptonuria 163
Alkaloids 96-105
Amebicides 43, 78
Amino acids ... 40, 41, 113, 114, 135, 157, 158
Amylases 2, 3
Anesthetics 62, 63
Analgesics 62
Antibiotics 33-59
Anticoagulants 79, 80
Anticonvulsants 60
Antifertility agents 74, 75
Antimalarials 77
Antipyretics 62
Antitubercular substances 76, 77
Arthritis 73
Asafoetida 9, 42
Ascorbic acid 7, 26-32, 166
Atherosclerosis 72
Aureomycin 75

Banana 109, 124
Biliary tract 70, 71
Biochemistry, experimental and clinical 153-168
Biotin 25
Blood 155, 158
Bronchial tree 71

Cancer 29, 154
Carbohydrases 2, 3
Carbohydrates 105-109, 143
Cardiovascular system 67-70
Carotene 11-14
Carpaine 98

PAGE

Chillies 51
Cholesterol 144
Choline esterase 161
Choline oxidase 1
Chloropromazine 61, 62
Citridol 44
Coconut water 36, 108, 109
Curds 15

Dairy equipment 179
Dairy husbandry 170, 171
Dairy management 179
Dairy plant 179
Dairy science 169-183
DHA reductase 6
Diabetes 71, 72, 120, 162
Diet surveys 138-143
Diosgenin 95, 96
Diuretics 79

Earthworms 36
Electrophoresis, agar 158-160
Electrophoresis, paper 48, 147, 164
Enniatin B 46
Enzymes 1-11
Eosinophilia 78
Erythrocyte 154, 155
Esterases 4
Essential oils 91-94

Fat 115-119
Fish proteins 135
Flavokinase 6
Flavonol 110
Fluorine 166
Folic acid 5, 6, 20-25
Fusaric acid 35

PAGE

Garlic 44
Gastro-intestinal tract 70
Ghee 174-176, 178
Glucose tolerance 160, 161, 165
Glycosides 105-109

Histamine 80
Histidase 7
Hypnotics 60

Jute 52, 53, 107 108, 122

Kwashiorkar 148, 149, 154

Lactobacteriaceae 42
Lipase 5, 42

Methionine 146
Microbiology 33-59
Milk 153, 172-174
Mitotic stages 34-35
Multipurpose food 136, 148
Mycobacterium tuberculosis ... 36, 44, 77, 108, 109

Nagli 138
Neuromuscular blocking 63
Nicotinic acid 17, 18, 104, 134
Nitrogen fixation 54
Nucleus 33, 34
Nutrition 132-152
Nutrition surveys 138-143
Nutritive values 132-138

Oedema 148, 149
Oils 91-94, 115-119

Pantothenic acid 19
Pasturella pestis 42, 43
Penicillin 45
Peptides 41

PAGE
Pharmacology 60-89
Phosphatase 2
Plant products 90-131
Proteases 4
Proteins 135, 147, 158-160
Protein inhibitor 7, 8
Pterygospermin 75
Pyridoxine 19
Q-enzyme 3
Radiation 146
Ranikhet disease 48
Rauwolfia alkaloids ... 64-67, 99-102, 103, 123
Riboflavin 17, 36, 39, 163
Rose 106
Serum proteins 158-160
Soil microbiology 49-54
Steroids 94-96
Sugars, effect of, on microorganisms 37
Sulfaguanidine 15
Tamarind 108, 109
Terpenoids 91-94
Thiaminase 6, 16
Thiamine 14, 15, 16, 39
Tuberculosis ... 36, 44, 76, 77, 108, 109, 157, 158
Urease 5
Uterus 71
Venoms 80
Vibrio cholerae 37, 47
Viruses 38
Vitamin A 11-14
Vitamin B_{12} 20-25, 38, 40, 72, 73
Vitamin C—See Ascorbic acid
Vitamin D 28
Vitamins 12-32, 72, 73
Waxes 115-116

Grams : THACHEM **Phone : 2160**

Thathadri Chemicals

15TH CROSS ROAD, MALLESWARAM
BANGALORE-3.

Offers are made from ready stocks

Roche reagents :

DL-B-Aminobutyric acid	Rs.	8/ g
DL-A-Aminobutyric acid		7/50 g
R-Aminobutyric acid		10/ g
L-Alanin		40/ g
L Citrullin		17/ 0.1g
L Glutamin		40/ g
DL Homocystin		38/ g
L-Methionin		39/ g
L-Threonin Swiss		89/ g
Cocarboxylase		30/ 0.1g
Vitamin A acetate cryst		24/ g
Vitamin A palmitate		26/ g
Vitamin K		7/ g
DL Alanyl glycin		73/ g
Chloracetyl-A-Tryptophan		8/ 0.1g
Chloracetyl-A-Leucin		37/ g
Glycyl D Leucin		15/ 0.1g
Glycyl D valin		15/ 0.1g
Glycyl glycin		18/ g
Glycyl L alanin		96/ g
Glycyl D alanin		96/ g
Gluthathion		78/ g
Hypoxanthin		36/ g

Other items :

Osmic acid BDH	48/ g
Naphthoresorcinol BDH	30/ g
Platinum chloride JM	29/ g
Gold chloride EM	12/ g
Triphenyl tetrazolium chloride NBC	69/ 5g
Dinitrofluorobenzene GR EM	30/ 10g
Methanol GR EM	25/ 500g
Butanol EM	28/ 1 kg

Indian Dairy Science Association

FOUNDED 1948

Devoted to the advancement and dissemination of
knowledge in regard to Dairy Science

PUBLICATIONS:

1. INDIAN JOURNAL OF DAIRY SCIENCE, Quarterly Research Journal. Annual Subscription Rs. 12/- £ 1/- $ 4.00. (Current Volume No. 11, 1958).
2. INDIAN DAIRYMAN, Monthly Non-technical Journal. Annual Subscription Rs. 6/- Sh. 10/- $ 2.00. (Current Volume No. 10, 1958).

MEMBERSHIP FEES OF THE ASSOCIATION, Rs. 12 p.a.

Further particulars can be had from :

THE HON. SECRETARY,
Indian Dairy Science Association
N.D.R.I. (S.R.S.) HOSUR ROAD, BANGALORE-1.

KURAZOL

(An Anti-Asthmatic Compound)
Liquid & Tablets
A Lightning remedy for ASTHMA

ADIOL COMPOUND

(An Anti-Ricketic, Anti-Catarrhal & Restorative Elixir)
for
Strength & Vitality

Manufactured by :

M/s. INTERNATIONAL CHEMICAL & BIOLOGICAL
INSTITUTE PRIVATE LTD.,
7, South End Road, Basavangudi, BANGALORE-4

Telegrams: 'KURAZOL' **Telephone : 3275**

The new Anti-cholinergic drug,
More effective and safe in gastro-duodenal ulcers,
hyperacidity and gastro-duodenal spasms.

SEDALCER

Each tablet contains:
Propantheline Bromide B.P. 25 mg.

Also available:

SEDALCER c̄ PHENOBARBITONE

Each tablet contains:

Propantheline Bromide B.P.	25 mg.
Phenobarbitone B.P.	15 mg.

* * * * *

A chemotherapeutic agent for covering and eradicating the four most common medical problems of modern times—

ASCARIASIS
FILARIASIS
EOSINOPHILOSIS

DICARBAMIN

Each tablet contains:	**Each teaspoonful contains:**
Di-ethyl carbamazine Citrate B.P.C. 50 mg.	Di-ethyl carbamazine Citrate B.P.C. 50 mg.

Each ml. contains:
Di-ethyl carbamazine Citrate B.P.C. 0.2 Gm.

* * * * *

Detailed literatures on request from:

THERAPEUTIC PHARMACEUTICALS

Administrative Offices:
43, Queen's Road,
BOMBAY-2

Biological & Pharmaceutical Laboratories:
54, Proctor Road, BOMBAY-7
38, Carter Road, BOMBAY-41

BENGAL CHEMICAL & PHARMACEUTICAL WORKS, Ld.

THE LARGEST CHEMICAL WORKS IN INDIA

Manufacturers of:

Pharmaceutical Drugs, Indigenous Medicines, Perfumery, Toilet and Medicinal Soaps, Surgical Dressings, Jexins, Sera and Vaccines, Disinfectants, Tar Products, Road Dressing Materials, etc.

Ether, Mineral Acids, Ammonia, Alum, Ferro-Alum, Aluminium Sulphate, Sulphate of Magnesium, Ferri Sulph, Caffeine and various other Pharmaceutical and Research Chemicals.

Surgical Sterilizers, Distilled Water Stills, Operation Tables, Instrument Cabinets and other Hospital Accessories.

Chemical Balance, Scientific Apparatus for Laboratories and Schools and Colleges, Gas and Water Cocks for Laboratory use, Gas Plants, Laboratory Furniture and Fittings.

FIRE EXTINGUISHERS, PRINTING INKS

Office:
9, GANESH CHUNDER AVENUE, CALCUTTA-13
Factories:
CALCUTTA, BOMBAY, KANPUR.

The Indian Journal of Medical Research
AND
The Indian Medical Research Memoirs

Published under the authority of the Indian Council of Medical Research with an **Editorial Board** consisting of the leading authorities on Tropical Medicine and allied subjects in India.

The **Indian Journal of Medical Research** will be published bi-monthly in January, March, May, July, September and November each year from January 1958 onwards. The Journal is the principal medium for publishing the results of the best medical research work being carried on in India.

Terms.—The subscription to the *Indian Journal of Medical Research* (*Memoirs* or *Supplementary* Numbers, if printed with any volume, will be charged for separately), is rupees twenty-five (or one pound, seventeen shillings and six pence) per volume per annum, post free; single copies rupees five (or seven shillings and six pence), postage extra plus *U. P. Sales Tax* where applicable.

JOB PRESS PRIVATE LIMITED
P. O. Box 124 - KANPUR

Protein Biscuits

INTRODUCING

VITAL PROTEIN

AS DIETARY SUPPLEMENT

IN

AN EXCEEDINGLY PLEASING AND
CONVENIENT FORM

THREPTIN BISCUITS

The Palatable

PROTEIN-CARBOHYDRATE-B-VITAMINS

FOOD

IN CRISP AND DELICIOUS BISCUITS

ACCESSIBLE EVEN TO LOWER INCOME GROUPS

CONTENTS PER OUNCE: (6 biscuits): Protein (intact casein) 50%, Carbohydrate 30%, Thiamine & Riboflavine 1 mg. each, Veg. Fat 7.5%, Flavouring Agents q.s.

Available in 1 lb. tins

Particulars from :

RAPTAKOS, BRETT & CO., PRIVATE LTD., WORLI-BOMBAY

'Roche' Vitamins

the first choice of the pharmaceutical industry

ROCHE

A
- Acetate in oil
- Palmitate in oil
- Acetate dry powder
- Palmitate water-miscible

BETA-CAROTENE

B1
- Thiamine Hydrochloride
- Thiamine Mononitrate

B2
- Riboflavin
- Riboflavin-5'-Phosphate Sodium

B6
- Pyridoxine Hydrochloride

PANTOTHENATES
- Calcium Pantothenate
- Sodium Pantothenate

NICOTINATES
- Niacin
- Niacinamide

BIOTIN

C
- Ascorbic Acid
- Coated Ascorbic Acid
- Sodium Ascorbate
- Calcium Ascorbate
- Ascorbyl Palmitate

E
- dl-Alpha Tocopherol Acetate
- dl-Alpha Tocopherol free
- Dry Vitamin E Acetate powder

Manufactured by: F. Hoffmann-La Roche & Co. Ltd., Basle (Switzerland)
Pioneers in vitamin research and leaders in the synthesis of pure vitamins

VOLTAS for Vitamins

a complete range of Vitamins is regularly stocked by Voltas in their special air conditioned godowns.

Sole Distributors:
VOLTAS LIMITED
Head Office: Bombay I.
Calcutta • Madras • Cochin • New Delhi • Bangalore • Kanpur

VT 5206